CATALOGUE

OF THE

MESOZOIC PLANTS

IN THE

DEPARTMENT OF GEOLOGY.

PART III.

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OF THE

MESOZOIC PLANTS

IN THE

DEPARTMENT OF GEOLOGY

BRITISH MUSEUM

(NATURAL HISTORY).

THE JURASSIC FLORA.

I.—THE YORKSHIRE COAST.

BY

A. C. SEWARD, M.A., F.R.S., F.G.S.,

UNIVERSITY LECTURER IN BOTANY AND FELLOW OF EMMANUEL COLLEGE, CAMBRIDGE.



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PREFACE.

THE principal source of the fine series of Jurassic plants from the Yorkshire Coast, now preserved in the British Museum, was the collection of the late Mr. William Bean, of Scarborough, acquired by purchase in 1859. Only a portion of this collection, however, is in the British Museum, the remainder being in the Yorkshire Philosophical Society's Museum at York.

Mr. Bean was an enthusiastic collector, and by means of his vast store of duplicate fossil plants he was able to make exchanges with many foreign museums. Specimens bearing labels in his well-known handwriting also exist in museums and private collections all over Britain.

A former resident of Scarborough, Dr. Murray, also gave many specimens to the British Museum in the early days, from Gristhorpe Bay and elsewhere along the Yorkshire coast.

The plant-bearing Oolitic shales of Yorkshire are much more friable than those of the Coal-measures. This may possibly explain the difficulty experienced in some instances in identifying 'types,' many of the specimens having been broken up and their parts separated, or even destroyed, by time and frequent removals.

The Oolitic plant-remains of Yorkshire are of peculiar interest, many of them having been carefully studied by

Brongniart, Lindley, Hutton, Saporta, and other Palæo-botanists of note, and it is very gratifying to find that so accomplished a botanist as Mr. A. C. Seward has now undertaken to Catalogue the Collection in the Geological Department which has remained for so long a time without a historian.

HENRY WOODWARD.

Department of Geology,
British Museum (Natural History),
Cromwell Road, S.W.

November 20, 1900.

AUTHOR'S PREFACE.

SPECIMENS of Jurassic plants from Gristhorpe Bay and other famous localities on the Yorkshire coast are met with in nearly every Museum in Britain, as well as in several continental collections. I have endeavoured to supplement the data afforded by the specimens in the British Museum by examining collections in other places: frequent allusion will be found in the descriptive part of this Catalogue to important types in provincial or continental museums. The Museums of Cambridge, Oxford, York, Scarborough, Whitby, Manchester, Newcastle, and Leeds are rich in Yorkshire Coast plants, and good collections have been examined also in Paris, Stockholm, Lund, and elsewhere. The British Museum series and the Leckenby Collection in the Geological Museum, Cambridge, are probably the richest in large and well-preserved specimens, but the other museums, especially those of Scarborough, Whitby, York, and Manchester, contain much material of considerable value. The identification of type-specimens has often been a difficult task: some of the specimens are probably lost; many have suffered considerably, partly through insufficient care having been exercised in their preservation and, to some extent, as the result of the natural breaking up of the shale in which the fossils occur. My search for type-specimens, which has often been

fruitless, has afforded a practical demonstration of the need of some system for the centralization and cataloguing of all specimens, which have served for the diagnosis or illustration of new species.

I desire to convey my hearty thanks to those in charge of the museums I have visited for their kindness in affording me every facility in the examination of collections, and for their willingness to assist my work in various ways. Among continental friends who have aided me I wish to express my gratitude to Professor Nathorst, who generously placed at my disposal some unpublished drawings of specimens collected by himself; also to Dr. Renault and Professor Zeiller, of Paris, who enabled me to obtain access to the Jurassic plants under their charge.

My thanks are due to Miss Woodward for the care with which she has executed the drawings published in this volume; to my wife I am also indebted for some of the drawings reproduced in the text, which were made from specimens in the museums of Whitby, Scarborough, and York. The photograph reproduced in Text-figure 34 was kindly taken for me by Mr. Gepp, of the Botanical Department.

The Councils of the Royal Society and the Literary and Philosophical Society of Manchester have allowed me to borrow process-blocks originally used in their publications, and the Syndics of the Cambridge University Press generously gave me permission to use several blocks in their possession.

A. C. SEWARD.

EMMANUEL COLLEGE, CAMBRIDGE.
November 20, 1900.

NOTE.

The numbers in brackets after the Authors' names in the footnotes refer to the year of publication of the work quoted.

A bibliography at the end of the volume includes the books and papers cited in the text.

LIST OF FIGURES IN THE TEXT.

INTRODUCTION.

ENGLAND.

The Jurassic plant-bearing strata exposed in the cliff sections of the Yorkshire coast, between Whitby and a few miles south of Scarborough, have afforded unusually rich data towards a restoration of the characteristics and composition of a certain facies of Mesozoic vegetation. The abundance of specimens in European museums and the descriptions of several British species in the works of Brongniart, Sternberg, Zigno, and other Continental palæobotanists, bear testimony to the wealth of material obtained from these Inferior Oolite rocks. The following passage from the first volume of Schimper's *Traité de paléontologie végétale* illustrates the importance, which this eminent palæobotanist attached to the investigation of the English Jurassic flora:—"On ne saurait assez recommander aux paléontologistes anglais l'étude approfondie de la flore fossile de l'oolithe de Yorkshire. C'est une des flores les plus intéressantes, à cause de sa grande ressemblance avec la flore de la formation rhétique et du lias inférieur et à cause de son rapport avec la flore crétacée. Les descriptions et les figures que nous en possédons sont insuffisantes pour arriver à une délimitation rigoureuse des genres et des espèces. Aussi ai-je dû passer sous silence un certain nombre de ces dernières faute de données exactes."[1] In the present volume an attempt is made to describe in detail the several elements composing the Jurassic flora of East Yorkshire, and to furnish a general sketch of the geographical distribution and botanical affinities of the vegetation represented by the Lower Oolite plants of this area.

[1] Schimper (69), vol. i. p. 485.

Historical Sketch.

We may begin[1] this brief historical survey of our knowledge of the Jurassic plants of Yorkshire with a reference to the well-known memoir by Young & Bird—*A Geological Survey of the Yorkshire Coast*,[2] published at Whitby in 1822. Mr. John Bird was Curator of the Whitby Museum, and the Rev. G. Young acted as one of the Secretaries of the Whitby Literary and Philosophical Society. The first part of this work deals with the geological structure of the strata which are described under various heads, such as the upper shales, oolitic limestone, second shale, ironstone and sandstone, blue limestone, sandstone, shale and coal, and Dogger; but most of these descriptive terms have not been adhered to by later geologists. In the second part a brief description is attempted of the organic remains, a few fossil plants being represented by crude coloured drawings; the type-specimens are preserved in the Whitby Museum, and a recent examination of the collection enabled me to identify most of the originals of Bird's figures. The second edition of the *Geological Survey of the Yorkshire Coast*, which appeared in 1828, contains various additional drawings of fossil plants.[3] The plants are compared with several recent genera such as *Asplenium*, *Scolopendrium*, *Hippuris*, *Cynaria*, *Gnaphalium*, and others, or they are merely spoken of as fragments of ferns or leaves. Reference is made to the figures of Young & Bird in the description of several species dealt with in the following pages.

It has been truly said that "Young & Bird's work did much to arouse the desire for geological pursuits, which eventually led to the establishment of the Museums at Whitby and Scarborough, and to the formation of such collections of fossils as were made by Bean, Williamson, and others."[4] The enthusiasm of these and other local naturalists resulted in the accumulation of rich collections, and, indeed, nearly the whole of the material at present

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[1] For a more complete history of our knowledge of the Jurassic rocks of East Yorkshire vide Fox-Strangways (92[1]), and for bibliographies of Jurassic literature vide also Phillips (75), Fox-Strangways (88), etc.

[2] Young & Bird (22).

[3] Young & Bird (28).

[4] Fox-Strangways (92[1]), p. 12.

available for the study of the fossil flora of East Yorkshire was obtained by their means. It is to be regretted that very little serious collecting has been undertaken during the last half-century; some of the famous localities which afforded so rich a harvest sixty or seventy years ago are probably almost worked out, but there is undoubtedly much valuable material to be found if local enthusiasm were again aroused. William Bean and his nephew John Williamson rendered excellent service in the early days of the geological exploration of the Yorkshire coast: the characteristic handwriting of the former is met with in most of our Museums on the labels of Yorkshire fossil plants; the latter began life as a gardener at Scarborough,[1] and afterwards became Curator of the Scarborough Museum, which owes many of its treasures to his skill as a scientific collector. John Williamson in later life was assisted in his natural-history work by his son William Crawford Williamson, whose brilliant palæobotanical researches date from his boyish days, when his father's zeal led him to take a share in interpreting the records of Jurassic life. The elder Williamson was acquainted with William Smith, whose name will always be prominently associated with Jurassic geology,[2] and with Smith's nephew, John Phillips, whose work on the Yorkshire Coast is one of the English classics. Adolphe Brongniart[3] was at this period engaged on his famous work on the history of fossil plants, and as the recognized authority received various Yorkshire specimens for identification, some of which he figured and described.

The following list includes the East Yorkshire species described by Brongniart in 1828:—

Equisetum columnare = *Equisetites columnaris*, Brongn.
Pachypteris lanceolata } = *Pachypteris lanceolata*, Brongn.
P. ovata }
Sphenopteris Williamsonis = *S. Williamsoni*, Brongn.
S. crenulata = ? *Coniopteris hymenophylloides* (Brongn.).[4]
S. denticulata = ? *S. Williamsoni*, Brongn.
S. hymenophylloides = *Coniopteris hymenophylloides.*
Cyclopteris digitata = *Ginkgo digitata* (Brongn.).

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[1] Williamson, W. C. (96), p. 3.
[2] Vide Phillips (44), p. 110, and Judd (98), p. 103.
[3] Brongniart (28[1] and 28[2]).
[4] The parentheses enclosing an author's name indicate that the generic name has been altered since the institution of the species [vide Seward (98), p. 111].

Glossopteris Phillipsii = *Sagenopteris Phillipsi* (Brongn.).
Tæniopteris vittata = *T. vittata*, Brongn.
Pecopteris denticulata = *Cladophlebis denticulata* (Brongn.).
P. Phillipsi = ? *C. denticulata.*
P. whitbiensis, *P. tenuis*, *P. Williamsonis* } = *Todites Williamsoni* (Brongn.).
P. Murrayana = *Coniopteris hymenophylloides* (Brongn.) and *Sphenopteris Murrayana* (Brongn.).
P. athyroides = ? *Coniopteris hymenophylloides* (Brongn.) or *Sphenopteris Murrayana* (Brongn.).
Phlebopteris polypodioides, *P. propinqua* } = *Laccopteris polypodioides* (Brongn.).
P. Schouwii = *Laccopteris*, sp.
P. undans = *Cladophlebis denticulata* (Brongn.).
P. Phillipsii = *Dictyophyllum rugosum*, L. & H.

Phillips' *Illustrations of the Geology of Yorkshire* was published in 1829, dedicated by an "affectionate nephew and grateful pupil" to William Smith. Phillips' book marked an important advance on that of Young & Bird, and placed the geology of East Yorkshire on a sound scientific basis; he included the plant-bearing strata in the "Bath Oolite formation," the term Oolite having been first applied to these rocks by Smith. The strata are classified by Phillips as follows:—

BATH OOLITE {
Cornbrash limestone.
Upper sandstone, shale and coal, with plants.
Impure limestone.
Lower sandstone, shale and coal, with plants.
Ferruginous beds—Dogger Series.

In the first edition of Phillips' work the respective positions of the grey limestone and millepore bed are confused, so that the Gristhorpe plant-bed,[1] which is now included in the middle estuarine series, was placed in the upper division.[2] This mistake was first pointed out by the late Professor Williamson,[3] and corrected in the later edition of Phillips' book. Phillips speaks of the fossil

[1] John Williamson is usually credited with the discovery of the famous Gristhorpe plant-bed. In a letter written to Lindley in 1832, William Bean asserts that he was "the first discoverer" of this bed. (I am indebted to Professor Lebour for an opportunity of reading Bean's letter.)
[2] Phillips, (29) p. 33.
[3] Williamson (37).

plants as belonging chiefly to "the natural monocotyledonous Orders, Filices, Lycopodiaceæ, Equisetaceæ, and Cycadaceæ," with associated fragments of dicotyledonous species. The plant-bearing sediments he describes as principally such as might be deposited by rivers varying in force, and subject to intervals of feebler action. The drawings of the plants are in many cases far from accurate, and it is not an easy matter to recognize the original specimens. Some of Phillips' type-specimens appear to have been lost, but others have been identified in the York Museum and elsewhere. In 1875 a third and much enlarged edition of Phillips' memoir was published under the editorship of Mr. Robert Etheridge. Professor Phillips did not live to see the publication of the third edition of his work; the concluding paragraph of the preface, written in 1874, the year of his death, is worthy of repetition.[1]

"The Yorkshire coast has ever been my delight: to sketch its romantic promontories, to climb and measure its cliffs, to investigate its numerous fossils and its rich variety of marine life, may be recommended to every lover of natural beauty and to every student of natural history. To them I bequeath what has been to me a labour of love, a life-long enjoyment—the study of the great Mesozoic section here so plainly cut,—not doubting that kindly thoughts will accompany the corrections and additions which time has brought, and still must bring, to the work which I now consign to their use."

The following list includes the species enumerated in the last edition, together with the names used in the first edition and their modern equivalents adopted in the present Catalogue. I have also added the name of the museum where the figured specimens may be seen, but there are still several species of which the originals have not been discovered.[2]

Fucoides arcuatus, L. & H. = *Marchantites erectus* (Leck.).
F. diffusus, Phill. = ? *M. erectus*.
F. erectus, Leck. (Type in the Leckenby Collection, Cambridge.) = *M. erectus*.
Equisetites columnaris, Brongn. = *Equisetites columnaris*.
E. lateralis, Phill. = *E. columnaris*.
Lycopodites falcatus, L. & H. = *Lycopodites falcatus*.

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[1] For a biographical notice of Phillips vide Geological Magazine, vol. vii. p. 301, 1870.

[2] Some of Phillips' type-specimens are referred to by Platnauer (91) as being in the York Museum.

Solenites Murrayanus, L. & H. (=*Flabellaria viminea*, Phill., 1829; type in the ? Whitby Museum, No. 2493) = *Czekanowskia Murrayana* (L. & H.).
S. furcatus, L. & H. = *Baiera Lindleyana* (Schimp.).
Baiera gracilis, Bunb. = *B. gracilis*.
B. microphylla, Phill. (Type-specimen in the Leckenby Collection, Cambridge.) = *B. Lindleyana* (Schimp.).
Cyclopteris longifolia, Phill. (= *Sphenopteris longifolia*, Phill., 1829; type-specimen in the York Museum) = *Baiera Phillipsi*, Nath.
C. digitata, Brongn. (= *Sphenopteris latifolia*, Phill., 1829; figured specimen in the York Museum) = *Ginkgo digitata*.
Dichopteris lanceolata (= *Neuropteris lanceolata*, Phill., 1829; figured specimen in the York Museum) = *Pachypteris lanceolata*, Brongn.
D. lævigata, Lign. (= *Neuropteris lævigata*, Phill., 1829) = *Pachypteris lanceolata*.
Phlebopteris polypodioides, Brongn. = *Laccopteris polypodioides* (Brongn.).
P. contigua, L. & H. = *L. polypodioides*.
P. crenifolia, Phill. = *L. polypodioides*.
P. Woodwardii, Leck. = *L. Woodwardi*.
P. Lindleyi, Göpp. = *Laccopteris polypodioides* (Brongn.).
P. Phillipsii, Brongn. (= *Phyllites nervulosa*, Phill., 1829; type of Phillips in the York Museum) = *Dictyophyllum rugosum*, L. & H.
P. Leckenbyi, Zign. = *D. rugosum*.
P. undans, Brongn. = *Cladophlebis denticulata* (Brongn.) (Fertile frond.)
Glossopteris Phillipsii, Brongn. (= *Pecopteris paucifolia*, Phill., 1829; figured specimen in the York Museum) = *Sagenopteris Phillipsi*.
Marzaria Simpsoni, Phill. (Type-specimen in the Whitby Museum.) = ? *Laccopteris polypodioides*.
Tæniopteris major, L. & H. (= *Aspleniopteris Nilssoni*, Phill., 1829; figured specimen in the York Museum) = *Tæniopteris major*. [The specimen figured by Phillips is an example of *Anomozamites Nilssoni* (Phill.).]
T. ovalis, Sternb. = ? *T. major*, L. & H.
T. vittata, Brongn. (= *Scolopendrium solitarium*, Phill., 1829) = *T. vittata*.
Pecopteris insignis, L. & H. = *Cladophlebis denticulata* (Brongn.).
P. denticulata, Brongn. = *C. denticulata*.
P. ligata, Phill. = *Laccopteris polypodioides* (Brongn.).
P. Phillipsii, Brongn. = *C. denticulata*.
P. polydactyla, Leck. = *Matonidium Goepperti* (Ett.).
P. cæspitosa, Phill. (Type-specimen in the York Museum.) = *Laccopteris polypodioides* (Brongn.).
P. whitbiensis, Brongn. (= *P. hastata*, Phill., 1829) = *Todites Williamsoni* (Brongn.).
P. dentata, L. & H. = *Todites Williamsoni*. [The specimen figured by Phillips is no doubt an example of *Cladophlebis denticulata*.]
P. Lindleyana, Presl = *Coniopteris arguta* (L. & H.).
P. curtata, Phill. = *Todites Williamsoni* (Brongn.).
P. Williamsonis, Brongn. [= *P. curtata* (pars), Phill., 1829] = *Todites Williamsoni*.
P. acutifolia, L. & H. } = *Coniopteris arguta* (L. & H.).
P. serrata (L. & H.) }
P. exilis, Phill. = *Klukia exilis* (Phill.).

Pecopteris undulata, Phill. }
P. inconstans, Phill. } = *Cladophlebis lobifolia* (L. & H.).
P. Haiburnensis, L. & H. = *C. haiburnensis.*
P. recentior, Phill. = *Todites Williamsoni* (Brongn.).
Sphenopteris Murrayana (Brongn.) = *S. Murrayana.*
S. athyroides (Brongn.) = ? *Coniopteris hymenophylloides* (Brongn.).
S. modesta, Leck. = *S. princeps*, Presl.
S. affinis, Phill. = *Coniopteris hymenophylloides* (Brongn.).
S. socialis, Phill. = *C. hymenophylloides.*
S. dissocialis, Phill. = *C. hymenophylloides.*
S. quinqueloba, Phill. = *C. quinqueloba.*
S. hymenophylloides, Brongn. = *C. hymenophylloides.*
S. crenulata, Brongn. = ? *Coniopteris hymenophylloides.*
S. arbuscula, Phill. = *Sphenopteris Murrayana* (pars), Brongn.
S. arbuscula, var. = *Coniopteris quinqueloba* (Phill.).
S. denticulata, Brongn. = ? *Sphenopteris Williamsoni*, Brongn.
S. Williamsoni, Brongn. (= *S. digitata*, Phill., 1829; figured specimen in the York Museum) = *S. Williamsoni.*
S. muscoides, Phill. (Type-specimen in the York Museum.) = *Coniopteris hymenophylloides.*
S. Jugleri, Leck. (Type-specimen in the Leckenby Coll., Cambridge.) = *Ruffordia Goepperti* (Dunk.).
"A skeletonized fern-branch."—Phillips, 1829, pl. viii. fig. 18. = Indeterminable fern. (Figured specimen in the York Museum.)
Ctenis falcata, L. & H. (= *Cycadites sulcicaulis*, Phill., 1829; type-specimen ? in the York Museum) = *Ctenis falcata.*
Odontopteris Leckenbyi, Leck., ex Bean MS. (Type-specimen in the Leckenby Coll., Cambridge.) = *Ptilozamites Leckenbyi.*
Tympanophora racemosa, L. & H. }
T. simplex, L. & H. } = *Coniopteris hymenophylloides.*
Tree-fern stem = ? tree-fern stem.
Otozamites Beanii (L. & H.). (Figured specimen in the Leckenby Coll., Cambridge.) = *Otozamites Beani.*
O. tenuatus (Bean MS.) = *O. Bunburyanus*, Zign.
O. parallelus, Phill. = *O. parallelus* (Phill.).
O. obtusus (L. & H.) = *O. obtusus*, var. *ooliticus.* [The type-specimen of *O. obtusus* (L. & H.), from the Lias of Axminster, which is in the Oxford Museum, is not specifically identical with the Yorkshire plant.]
O. graphicus, Leck., ex Bean MS. (Type-specimen in the Leckenby Coll., Cambridge.) = *O. graphicus.*
O. acuminatus (L. & H.) = *O. acuminatus.*
O. gramineus, Phill. (The original of Zigno's figure is in the Leckenby Coll., Cambridge.)
O. lanceolatus, Phill. (= *Cycadites lanceolatus*, Phill., 1829) }
O. latifolius (Phill.) (= *Cycadites latifolius*, Phill., 1829; type-specimen in the York Museum) } = *Otozamites acuminatus* (L. & H.).
O. gracilis (Leck., ex Bean MS.). (Type-specimen in the Leckenby Coll., Cambridge.) = *Williamsonia pecten* (Phill.).

Williamsonia gigas (L. & H.). (Figured specimens in the Whitby Museum.) = *W. gigas.*

Zamites lanceolatus, L. & H. = *Podozamites lanceolatus.*

Pterophyllum pectinoideum (Phill.). (= *Cycadites pectinoides*, Phill., 1829.) = *Williamsonia pecten.*

P. medianum, Leck., ex Bean MS. = *Nilssonia mediana.*

P. pecten (Phill.) (= *Cycadites pecten*, Phill., 1829) = *Williamsonia pecten.*

P. comptum, Phill. (= *Cycadites comptus*, Phill., 1829) = *Nilssonia compta.*

P. angustifolium, Leck., ex Bean MS. (Type-specimen in the Leckenby Coll., Cambridge.)
P. tenuicaule, Phill. (= *Cycadites tenuicaulis*, Phill., 1829)
} = *N. mediana* (Leck., ex Bean MS.).

? *P. Nilssoni*, L. & H.
? *P. minus*, L. & H.
} = *Anomozamites Nilssoni* (Phill.).

P. rigidum, Phill.

Cycadites zamioides, Leck. (Type-specimen in the Leckenby Coll., Cambridge.) = *Taxites zamioides* (Leck., ex Bean MS.).

Araucarites Phillipsii, Carr. = *Araucarites Phillipsi.*

Brachyphyllum mamillare, Brongn. = *Brachyphyllum mamillare.*

B. setosum, Phill. = *Cheirolepis setosus.*

Thuytes expansus, Sternb. = *B. mamillare.*

Walchia Williamsonis (Brongn.) (= *Lycopodites uncifolius*, Phill., 1829, and "spike of *Lycopodites*"; original of latter, which is in the York Museum, = male flower) = *Pagiophyllum Williamsoni.*

Cryptomerites divaricatus, Bunb.
C. rigidus, Phill. (A specimen very similar to the type is in the Manchester Museum.)
} = *Cryptomerites divaricatus*, Bunb.

Taxites laxus, Phill. = *Taxites zamioides* (Leck., ex Bean MS.).

Sphæreda paradoxa, L. & H. (and "winged seed," Phillips, 1829) = *Beania gracilis*, Carr.

"Unknown leaves," Phillips, 1829, pl. vii. fig. 23. (Figured specimen in the York Museum.) = ? *Ginkgo digitata* (pollen-sacs of male flower).

"Small vegetable bodies in groups," Phillips, 1829, pl. vii. fig. 25. (Figured specimen in the York Museum.) = ? small seeds.

In 1829 there also appeared an important paper by Murchison *On the Coalfield of Brora, in Sutherlandshire, and some of the stratified deposits in the North of Scotland.*[1] Murchison's attention was first called to this district by Buckland & Lyell, who visited Brora in 1824, and were led to express the opinion that the Sutherlandshire Coalfield should be included in the Oolite division of the Jurassic system. König contributed some notes on an equisetaceous plant, which he named *Oncylogonatum carbonarium*

[1] Murchison (29).

(no doubt identical with *Equisetites columnaris*, Brongn.), and on some "subtriangular or inversely cordate carbonaceous plates," which are probably the scales of a female Araucarian cone. In referring to the Brora plants, Murchison makes the following observation: — "If the mode of distribution and the generic characters of these fossil plants be ever reduced under general laws, they will no longer be regarded as anomalies, but will form an important addition to the natural history of the beds with which they are associated."[1]

The *Fossil Flora of Great Britain*, by Lindley & Hutton, which appeared in parts between the years 1831 and 1837,[2] contains drawings and descriptive notes of several species of Jurassic plants; several of these were communicated by the younger Williamson, and others by Bean, Murray, Dunn, and Phillips. There is an interesting reference in Williamson's autobiography to his share in the production of the *Fossil Flora*. He speaks of Mr. Dunn, Secretary to the Literary and Philosophical Society of Scarborough, as having urged him to undertake the drawings, which were made "at one end of Mr. Weddell's kitchen-table, whilst the housekeeper was occupied at the other end with the several processes of providing the day's dinner."[3] Williamson was at this time a medical student living in the house of Mr. Thomas Weddell, a practitioner in Scarborough.

The following list includes such plants from Yorkshire as are figured by Lindley & Hutton. I have added the modern names, and mentioned the museums in which I have seen some of the figured specimens. The date of publication is appended in each case.[4]

Cyclopteris Beani. Pl. 44, 1832. (Type-specimen in the Scarborough Museum.) = *Otozamites Beani* (L. & H.).
Pecopteris polypodioides. Pl. 60, 1832. = *Laccopteris polypodioides* (Brongn.).
Lycopodites falcatus. Pl. 61, 1832. (Type in the British Museum, No. 39,314.) = *Lycopodites falcatus*.
Tæniopteris vittata. Pl. 62, 1833. = *T. vittata*, Brongn.
Glossopteris Phillipsii. Pl. 63, 1833. (Figured specimens in the British Museum, Nos. 39,221 and 39,222.) = *Sagenopteris Phillipsi* (Brongn.).

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[1] Murchison (29), p. 317.
[2] Lindley & Hutton (31–37).
[3] Williamson (96), p. 36.
[4] Bolton (92) does not include any of the Yorkshire Coast plants in his list of figured specimens in the Manchester Museum.

Cyclopteris digitata. Pl. 64, 1833. = *Ginkgo digitata* (Brongn.).
Pterophyllum comptum. Pl. 66, 1833. = *Nilssonia compta* (Phill.).
? *P. minus.* Pl. 67, fig. 1, 1833. } = *Anomozamites Nilssoni.*
P. Nilssoni. Pl. 67, fig. 2, 1833. }
Neuropteris recentior. Pl. 68, 1833. = *Todites Williamsoni* (Brongn.).
N. ligata. Pl. 69, 1833. = *Cladophlebis denticulata* (Brongn.).
N. undulata. Pl. 83, 1833. = *Cladophlebis lobifolia* (Phill.).
Tæniopteris major. Pl. 92, 1833. (Type in the Manchester Museum.) = *T. major*, L. & H.
Lycopodites Williamsonis. Pl. 93, 1833. (Type in the Manchester Museum.) = *Pagiophyllum Williamsoni* (Brongn.).
Pterophyllum pecten. Pl. 102, 1834. = *Williamsonia pecten* (Phill.).
Ctenis falcata. Pl. 103, 1834. = *Ctenis falcata*, L. & H.
Dictyophyllum rugosum. Pl. 103, 1834. = *Dictyophyllum rugosum*, L. & H.
Neuropteris arguta. Pl. 105, 1834. = *Coniopteris arguta* (L. & H.).
Pecopteris insignis. Pl. 106, 1834. (Counterpart of type-specimen in the Leckenby Coll., Cambridge.) = *Cladophlebis denticulata* (Brongn.).
P. propinqua. Pl. 119, 1834. (Type in the Scarborough Museum.) = *Laccopteris polypodioides* (Brongn.).
P. undans. Pl. 120, 1834. (Type in the Scarborough Museum.) = *Cladophlebis denticulata* (Brongn.) (fertile frond).
Solenites Murrayana. Pl. 121, 1834. (Type in the British Museum, No. V. 3685.) = *Czekanowskia Murrayana* (L. & H.).
Pecopteris Williamsonis. Pl. 126, 1834. = *Todites Williamsoni* (Brongn.).
Sphenopteris Williamsonis. Pl. 131, 1834. (Type in the Scarborough Museum.) = *S. Williamsoni* (Brongn.).
Otopteris acuminata. Pl. 132, 1834. (Type in the Scarborough Museum; upper part of figure.) = *Otozamites acuminatus* (L. & H.).
Pecopteris whitbiensis. Pl. 134, 1834. = *Cladophlebis denticulata* (Brongn.).
Phlebopteris contigua. Pl. 144, 1835. (Type in the York Museum.) = *Laccopteris polypodioides* (Brongn.).
Sphenopteris serrata. Pl. 148, 1835. = *Coniopteris arguta* (L. & H.).
Otopteris cuneata. Pl. 155, 1835. (Type in the Manchester Museum.) = *Sagenopteris Phillipsi* (Brongn.).
Pecopteris acutifolia. Pl. 157, 1835. = *Coniopteris arguta* (L. & H.).
P. obtusifolia. Pl. 158, 1835. = *Klukia exilis* (Phill.).
Sphæreda paradoxa. Pl. 159, 1835. = *Beania gracilis*, Carr.
Zamia gigas. Pl. 165, 1835. = *Williamsonia gigas* (L. & H.).
Thuites expansus. Pl. 167, 1835. (Type in the Manchester Museum.) = *Brachyphyllum mamillare*, Brongn.
Sphenopteris arguta. Pl. 168, 1835. (Type in the Manchester Museum.) = *Coniopteris hymenophylloides* (Brongn.).
Pecopteris dentata. Pl. 169, 1835. (Type in the Manchester Museum.) = *Todites Williamsoni* (Brongn.).
Tympanophora simplex. Pl. 170A, 1835. = *Coniopteris hymenophylloides* (Brongn.).
Pecopteris lobifolia. Pl. 179, 1836. = *Cladophlebis lobifolia* (Phill.).
Fucoides arcuatus. Pl. 185, 1836. = *Marchantites erectus* (Leck.).
Equisetum laterale. Pl. 186, 1836. = *Equisetites columnaris* (Brongn.).

Pecopteris haiburnensis. Pl. 187, 1836. (Type in the Newcastle Museum.[1]) = *Cladophlebis haiburnensis* (L. & H.).
Brachyphyllum mamillare. Pls. 188 and 219, 1836 and 1837. = *B. mamillare* (Brongn.).
Zamia lanceolata. Pl. 194, 1836. (Type in the Manchester Museum.) = *Podozamites lanceolatus* (L. & H.).
? *Otopteris acuminata*, var. *brevifolia.* Pl. 208, 1837. = *Otozamites acuminatus* (L. & H.).
? *Solenites furcata.* Pl. 209, 1837. = *Baiera Lindleyana* (Schimp.).
? *Otopteris ovalis.* Pl. 210A, 1837. (Type in the Scarborough Museum.) = ? *Tæniopteris major*, L. & H.
? *Filicites scolopendrioides*, Brongn. Pl. 229, 1837.

The volume of *Illustrations of Fossil Plants* edited by Professor Lebour, consisting of autotype reproductions of drawings prepared for Lindley & Hutton, contains two plates of Lower Oolite plants :—[2]

Sphenopteris quinqueloba, var. *arbuscula*, Phill. Pl. 38. = *Coniopteris quinqueloba* (Phill.).
Cryptomerites divaricatus. Pl. 57. = *Cryptomerites divaricatus*, Bunb.

In Williamson's papers read before the Geological Society in 1834 and 1836,[3] a list is given of Oolitic plants, but one of the most important additions to the geology of the plant-bearing strata in these contributions is the correction of Phillips' mistake as to the horizon of the Gristhorpe plant-bed.

An important paper was read before the Geological Society of London in 1851 by Bunbury,[4] *On some Fossil Plants from the Jurassic Strata of the Yorkshire Coast*, in which several species are critically discussed, and illustrated by accurate drawings; the species specially referred to include the following :—

Sphenopteris nephrocarpa, Bunb. (Type in the Leckenby Collection, Cambridge.) = *Coniopteris hymenophylloides* (Brongn.).
Baiera gracilis, Bunb. (Type in the Bunbury Collection, Botanical Museum, Cambridge.) = *Baiera gracilis.*
Sagenopteris cuneata (L. & H.) = *Sagenopteris Phillipsi* (Brongn.).
Pecopteris cæspitosa, Phill. = *Laccopteris polypodioides* (Brongn.).
Acrostichites Williamsoni (Brongn.) = *Todites Williamsoni* (Brongn.).
Pecopteris exilis, Phill. [Bunbury's figured specimen is in the Botanical Museum, Cambridge; refigured, Seward (94), p. 197.] = *Klukia exilis* (Phill.).

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[1] On the authority of Professor Lebour (78), p. 115.
[2] Lebour (77).
[3] Williamson (37), p. 238.
[4] Bunbury (51); Seward (94[2]).

Asterophyllites? lateralis (Phill.) = *Equisetites columnaris*, Brongn.
Calamites Beani, Bunb. [Type in the Manchester Museum; figured by Gardner (86), pl. ix. fig. 2; vide also Seward (98), fig. 60.] = *Equisetites Beani* (Bunb.).
Cryptomerites? divaricatus, Bunb. (Type in the Leckenby Coll., Cambridge.) = *Cryptomerites divaricatus*, Bunb.
Palissya? Williamsonis = *Pagiophyllum Williamsoni* (Brongn.).

The two folio volumes by Zigno entitled *Flora Fossilis Formationis Oolithicæ*, published between 1856 and 1885,[1] contain numerous references to British Jurassic plants; these are quoted in the lists of synonyms of the various species dealt with in the Catalogue.

In Hugh Miller's *Testimony of the Rocks*,[2] reference is made to the occurrence of several plants in the Helmsdale deposits of Sutherlandshire[3] identical with Lower Oolite species from the Yorkshire coast. The Mesozoic flora of Scotland is in need of further investigation, and it is proposed to deal elsewhere with the botany and geology of these northern species.

In 1864 Leckenby[4] described and figured "some new or imperfectly known species" of East Yorkshire plants; most of the specimens dealt with are included in the Leckenby Collection, which Professor Adam Sedgwick purchased in 1872 for the Woodwardian Museum, Cambridge:—[5]

Cycadites zamioides, Leck. (Type in the Leckenby Coll., Woodwardian Museum, Cambridge.) = *Taxites zamioides* (Leck., ex Bean MS.).
Palæozamia pecten = *Williamsonia pecten* (Phill.).
Pterophyllum comptum = *Nilssonia compta* (Phill.).
P. medianum, Leck., ex Bean MS. } = *N. mediana* (Leck., ex Bean MS.).
P. angustifolium, Leck., ex Bean MS. }
? *P. minus*, L. & H. = *Anomozamites Nilssoni* (Phill.).
Ctenis Leckenbyi, Leck., ex Bean MS. = *Ptilozamites Leckenbyi*.
Otopteris mediana, Leck. (Type in the Leckenby Coll.) = *Otozamites Beani* (L. & H.).
O. lanceolata, Leck., ex Bean MS. = *Williamsonia pecten* (Phill.).
O. graphica, Leck., ex Bean MS. (Type in the Leckenby Coll.) = *Otozamites graphicus* (Leck., ex Bean MS.).
O. tenuata, Leck., ex Bean MS. (Type in the Leckenby Coll.) = *O. Bunburyanus*, Zign.

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[1] Zigno (56–85).
[2] Miller (57), pp. 477 et seq.
[3] Vide also Judd (73).
[4] Leckenby (64).
[5] Clark, J. W. & Hughes, T. McKenny (90), vol. ii. p. 465.

Tympanophora simplex, L. & H. } = *Coniopteris hymenophylloides* (Brongn.).
T. racemosa, L. & H. }

Sphenopteris modesta, Leck., ex Bean MS. (Type in the Leckenby Coll.) = *Sphenopteris princeps*, Presl.

S. Jugleri, Ett. (Type in the Leckenby Coll.) = *Ruffordia Goepperti* (Dunk.).

Neuropteris arguta, L. & H. (Figured specimen in the Leckenby Coll.) = *Coniopteris arguta* (L. & H.).

Pecopteris polydactyla, Göpp. (Figured specimen in the Leckenby Coll.) = *Matonidium Goepperti* (Ett.).

Phlebopteris propinqua (L. & H.). = *Laccopteris polypodioides* (Brongn.).

Phlebopteris Woodwardii, Leck. (Type in the Leckenby Coll.) = *Laccopteris Woodwardi* (Leck.).

Fucoides erectus, Leck., ex Bean MS. (Type in the Leckenby Coll.; refigured, Seward (98), p. 233.) = *Marchantites erectus* (Leck., ex Bean MS.).

The writings of Morris,[1] Carruthers,[2] Starkie Gardner,[3] and others contain scattered references to descriptions of Lower Oolite plants; several species of the British Jurassic flora are dealt with also by Saporta[4] in his Monograph on the plants of this period.

The most important of the more modern contributions to our knowledge of the Jurassic plants of England is unfortunately written in the Swedish language, and is not accompanied by any illustrations. In 1880 Nathorst[5] published a series of notes on his visits to various English Museums, together with observations made in the field at some of the principal plant localities on the Yorkshire coast. The same author discovered a new plant-bed between White Nab and Scarborough, which enabled him to add some new species to the Lower Oolite flora. Nathorst's notes have proved of considerable value in the examination of the Yorkshire plants, and his opinions on the several species are frequently referred to in the descriptive part of this Catalogue. The following new species are mentioned or briefly described, but in some cases I have been led to identify them with species previously recorded. Whether or not Nathorst's supposed new species should be retained, there can be no question as to the great value of his critical notes.

Anthrophyopsis, n.sp. = *Ctenis*, sp.

Nilssonia tenuinervis, n.sp. = *Nilssonia tenuinervis*, Nath.

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[1] Morris (41).

[2] Carruthers (66) (67) (69[1]) (69[2]) (70).

[3] Gardner (86).

[4] Saporta (73) (75) (84) (91).

[5] Nathorst (80).

Ginkgo whitbiensis, n.sp. (Type in the British Museum, No. 39,331.) = *Ginkgo whitbiensis*, Nath.
Otozamites distans, n.sp.
Czekanowskia Heeri, n.sp.
Taxites brevifolius, n.sp.

Among the works dealing more especially with the stratigraphy of the Lower Oolite rocks of Yorkshire, reference may be made to the Geological Survey Memoirs by Messrs. Fox-Strangways, Barrow,[1] and H. B. Woodward,[2] and to a series of valuable papers by Hudleston,[3] published in the Proceedings of the Geologists' Association, also to Etheridge's Presidential Address of 1882.[4]

The second volume of the Geological Survey Memoirs on the Jurassic rocks of Britain, contains a long list of fossils by Fox-Strangways, who acknowledges assistance in the revision of the plants by Clement Reid.[5] As this is the most recent list of plants hitherto published, and is largely founded on the notes by Nathorst to which reference has already been made, I have enumerated those species from Fox-Strangways' list which are referred to as "species now recognized," adding in each case the names employed in the present Catalogue. A change of nomenclature has been adopted in several instances, the reasons for the changes being stated in the description of each species :—

Equisetum columnare, Brongn. = *Equisetites columnaris* Brongn.
Fucoides arcuatus, L. & H. } = *Marchantites erectus* (Leck., ex Bean MS.).
F. erectus, Bean MS. }
Lycopodites falcatus, L. & H. = *Lycopodites falcatus*, L. & H.
Phyllotheca lateralis, Phill. = *Equisetites columnaris*, Brongn.
Sagenopteris cuneata, L. & H. } = *Sagenopteris Phillipsi* (Brongn.).
S. Phillipsii, Brongn. }
Schizoneura Beanii, Bunb. = *Equisetites Beani* (Bunb.).
Acrostichites princeps, Presl = *Sphenopteris princeps*, Presl.
A. tenuis, Brongn. } = *Todites Williamsoni* (Brongn.).
A. Williamsonis, Brongn. }
Anthrophyopsis, n.sp. = *Ctenis*, sp.
Asplenium argutulum, Heer = *Cladophlebis denticulata* (Brongn.).
A. Petruschiense, Heer = ? *C. denticulata.*
A. whitbiense, Brongn. = *Cladophlebis denticulata* (Brongn.).

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[1] Fox-Strangways & Barrow (82) ; Fox-Strangways (88) (92[1]) (92[2]).
[2] Woodward, H. B. (95).
[3] Hudleston (74) (76) (78).
[4] Etheridge (82).
[5] Fox-Strangways (92[2]).

Clathropteris Whitbiensis, Brongn. MS. = *Dictyophyllum rugosum*, L. & H.
Dicksonia hymenophylloides, Brongn. = *Coniopteris hymenophylloides* (Brongn.).
D. nephrocarpa, Bunb. = *C. hymenophylloides*.
Dictyophyllum Leckenbyi, Zigno
D. Nilssoni, Brongn. } = *Dictyophyllum rugosum* (L. & H.).
D. rugosum, L. & H.
Marzaria Simpsoni, Phill. = ? *Laccopteris polypodioides* (Brongn.).
Pachypteris lanceolata, Brongn. = *Pachypteris lanceolata* (Brongn.).
Pecopteris acutifolia, L. & H. = *Coniopteris arguta* (L. & H.).
P. arguta, L. & H. = *C. arguta*.
P. cæspitosa, Phill. = *Laccopteris polypodioides* (Brongn.).
P. curtata, Phill. = *Todites Williamsoni* (Brongn.).
P. dentata, L. & H. = *Todites Williamsoni* (Brongn.).
P. denticulata, Brongn. = *Cladophlebis denticulata* (Brongn.).
P. exilis, Phill. = *Klukia exilis* (Phill.).
P. haiburnensis, L. & H. = *Cladophlebis haiburnensis* (L. & H.).
P. inconstans, Phill. } = *Cladophlebis lobifolia* (Phill.).
P. lobifolia, Phill.
P. polydactyla, Göpp. = *Matonidium Goepperti* (Ett.).
P. undans, L. & H. = *Cladophlebis denticulata* (Brongn.).
P. undulata, L. & H. = *Cladophlebis lobifolia* (Phill.).
Phlebopteris contigua, L. & H. } = *Laccopteris polypodioides* (Brongn.).
P. polypodioides, Brongn.
P. Woodwardii, Leck. = *Laccopteris Woodwardi* (Leck.).
Sphenopteris affinis, Phill. = *Coniopteris hymenophylloides* (Brongn.).
S. arbuscula, Phill. = ? *Sphenopteris Murrayana* (Brongn.).
S. arguta, L. & H. = *Coniopteris hymenophylloides* (Brongn.).
S. athyroides, Brongn. = *C. hymenophylloides* or *S. Murrayana*.
S. crenulata, Brongn. } = *Coniopteris hymenophylloides* (Brongn.).
S. dissocialis, Phill.
S. Jugleri, Ett. = *Ruffordia Goepperti* (Dunk.).
S. muscoides, Phill. = *Coniopteris hymenophylloides* (Brongn.).
S. quinqueloba, Phill. = *Coniopteris quinqueloba* (Phill.).
S. socialis, Phill. = *Coniopteris hymenophylloides* (Brongn.).
S. Williamsonis, Brongn. = *Sphenopteris Williamsoni*, Brongn.
Tæniopteris major, L. & H. = *Tæniopteris major*, L. & H.
T. ovalis, Sternb. = ? *Tæniopteris major*, L. & H.
T. vittata, Brongn. = *Tæniopteris vittata*, Brongn.
Thyrsopteris Maakiana, Heer = *Coniopteris hymenophylloides* (Brongn.).
T. Murrayana, Brongn. = *Sphenopteris Murrayana* (Brongn.).
Anomozamites Lindleyanus, Schimp. = *Anomozamites Nilssoni* (Phill.).
Araucaria Phillipsii, Carr. = *Araucarites Phillipsi*, Carr.
Baiera gracilis, Bunb. = *Baiera gracilis*, Bunb.
B. longifolia, Phill. = *Baiera Phillipsi*, Nath.
B. microphylla, Phill. = *Baiera Lindleyana* (Schimp.).
Beania gracilis, Carr. = *Beania gracilis*, Carr.
Brachyphyllum mamillare. Brongn. = *Brachyphyllum mamillare*, Brongn.
B. setosum, Phill. = *Cheirolepis setosus* (Phill.).
Cryptomerites divaricatus, Bunb. = *Cryptomerites divaricatus*, Bunb.

Cryptomerites rigidus, Phill. = *Cryptomerites divaricatus*, Bunb.
Ctenis falcata, L. & H. = *Ctenis falcata*, L. & H.
Cycadites zamioides, Leck. = *Taxites zamioides* (Leck., ex Bean MS.).
Czekanowskia Heeri, Nath.
C. rigida, Heer = *Czekanowskia Murrayana* (L. & H.).
C. setacea, Heer.
Ginkgo digitata, Brongn. = *Ginkgo digitata* (Brongn.).
G. Huttoni, Sternb. = *G. digitata* (Brongn.), var. *Huttoni*.
G. whitbiensis, Nath. = *G. whitbiensis*, Nath.
Nilssonia angustifolia, Bean MS. = *Nilssonia mediana* (Leck., ex Bean MS.).
N. compta, Phill. = *N. compta* (Phill.).
N. mediana, Bean MS. }
N. tenuicaulis, Phill. } = *N. mediana*.
N. tenuinervis, Nath. = *N. tenuinervis*, Nath.
Otozamites acuminatus, L. & H. = *Otozamites acuminatus* (L. & H.).
O. Beanii, L. & H. = *O. Beani* (L. & H.).
O. distans, Nath.
O. gracilis, Phill. = *Williamsonia pecten* (Phill.).
O. gramineus, Phill.
O. graphicus, Bean MS. = *O. graphicus* (Leck., ex Bean MS.).
O. lanceolatus }
O. latifolius, Phill. } = *O. acuminatus* (L. & H.).
O. medianus, Leck. = *O. Beani* (L. & H.).
O. obtusus, L. & H. = *O. obtusus*, var. *ooliticus*.
O. parallelus, Phill.
O. tenuatus, Bean, sp. = *O. Bunburyanus*, Zign.
Podozamites distans, Presl }
P. lanceolatus, L. & H. } = *Podozamites lanceolatus* (L. & H.).
P. lanceolatus, var. *minor*, Schenk }
Pterophyllum rigidum, Phill.
Ptilozamites Leckenbyi, Bean, sp. = *Ptilozamites Leckenbyi* (Leck., ex Bean MS.).
Schizolepis, sp.
Solenites furcata, L. & H. = *Baiera Lindleyana* (Schimp.).
S. Murrayana, L. & H. = *Czekanowskia Murrayana*.
Sphercæda paradoxa, L. & H. = *Beania gracilis*, Carr.
? *Sphænozamites undulatus*, Sternb. = *Williamsonia gigas* (L. & H.).
Taxites brevifolius, Nath.
T. laxus, Phill. = *Taxites zamioides* (Leck., ex Bean MS.).
Thuytes expansus, Sternb. = *Brachyphyllum mamillare*, Brongn.
Walchia Williamsonis, Brongn. = *Pagiophyllum Williamsoni* (Brongn.).
Williamsonia gigas, L. & H. = *Williamsonia gigas* (L. & H.).
W. hastula, Bean MS. }
W. pecten, Phill. } = *W. pecten* (Phill.).

A glance at a geological map of England reveals the existence of a band of Jurassic rocks stretching diagonally across England from the coast of Yorkshire to Dorsetshire in the south-west. Between the Yorkshire strata and those of corresponding age in the midland

and south-west districts there is a striking difference as regards petrological characters, thickness, and fossil contents. The sedimentary rocks in the north-eastern area consist of a considerable thickness of estuarine or freshwater deposits, with here and there

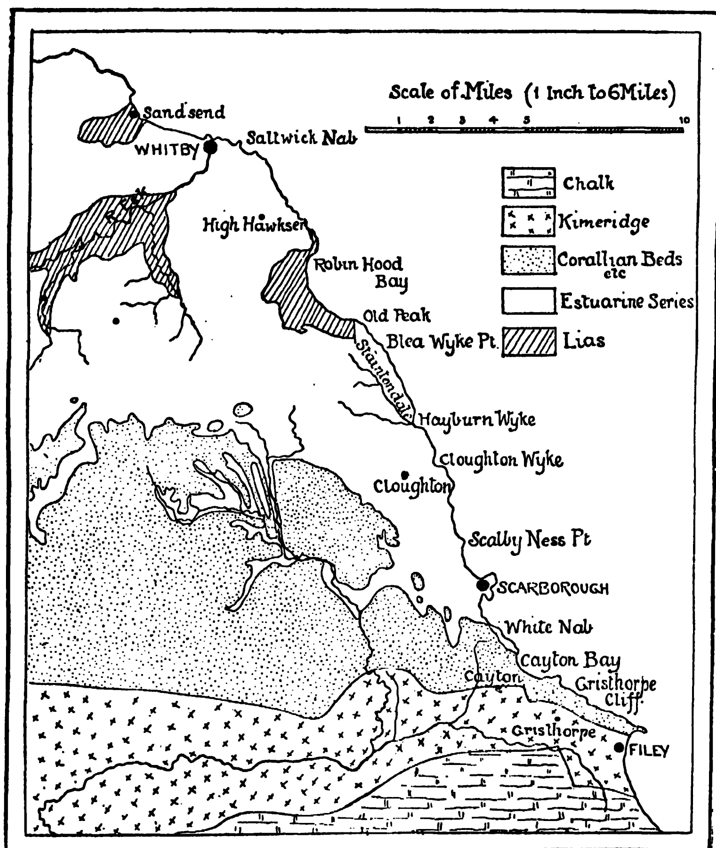


FIG. 1.—Geological Sketch-map of part of East Yorkshire.

a thin marine band, whereas in the other districts the Lower Oolite rocks are almost exclusively of marine origin. The country between Whitby and a few miles south of Scarborough is occupied by Middle and Lower Oolite and Liassic strata; the accompanying

map shows the position of the most important localities in this part of the coast from which Lower Oolite plants have been obtained.

The sketch-map shown in Fig. 1 is a simplified form of part of the larger map published in the volume of the International Geological Congress of 1888. While illustrating the relation of the Estuarine Series of the Inferior Oolite (Bajocian) to the Middle and Upper Oolite and to the Cretaceous rocks, it marks the position of the chief localities from which the fossil plants dealt with in the following pages have been obtained.

The moorlands and bold headlands of North-East Yorkshire constitute an elevated region which is bounded on the west by the low-lying Triassic plain of Central Yorkshire. Geologically this district is marked off from the other Jurassic areas by well-defined characters; the rocks composing it are chiefly arenaceous, with some Oolitic limestones and ironstones and a few thin seams of coal. The occurrence of some subordinate marine beds affords evidence of the frequent oscillations of level in this part of England during the Jurassic period. Broadly speaking, the East Yorkshire rocks of Lower Oolite age consist of three important Estuarine Series separated from one another by thin bands containing marine fossils. The following classification illustrates the relative positions of these two types of sediments:—

LOWER OOLITE.	Cornbrash.
	Upper Estuarine Series.
	Scarborough or Grey Limestone Series.
	Middle Estuarine Series.
	Millepore Series.
	Lower Estuarine Series.
	The Dogger and Blea Wyke beds.

These Lower Oolite rocks of England are correlated with part of the Middle or Brown Jura of Germany (L. von Buch and Quenstedt; = Dogger of Oppel), and with the Bathonian and Bajocian of French geologists.[1]

The Yorkshire *Dogger*, exposed in the cliff sections of Blea Wyke, High Whitby, Saltwick, and elsewhere, forms the lowest member of the Lower Oolite rocks; it is a littoral formation,

[1] Fox-Strangways (88), p. 132; Kayser (95), p. 238.

consisting largely of rounded blocks (the so-called doggers) of sandstone and ironstone.

The *Lower Estuarine Series*, exposed at various localities on the coast between Robin Hood Bay and Huntcliff (the latter is situated a few miles further north than the coastline shown in the map), consists of a considerable thickness of arenaceous and argillaceous sediments, associated with beds of oolitic ironstone, thin coal-seams, and an abundance of carbonaceous matter. This succession of estuarine sediments containing plant remains is capped by a thin marine band known as the *Eller Beck bed*. This is succeeded by the *Millepore bed*, so called from the occurrence of the Polyzoan *Haploœcia straminea*[1] (Phill.) (= *Millepora* and *Cricopora straminea*), which consists of ferruginous sandstone and limestone, and is exposed at Cloughton Wyke in its arenaceous facies, and at Gristhorpe Bay and Cayton Bay as a limestone. Above the Millepore bed we pass up into the second series of freshwater or estuarine beds, known as the *Middle Estuarine Series*. These deposits constitute the principal coal-bearing series in the Inferior Oolite, and include the famous plant-bed of Gristhorpe Bay. From the Middle Estuarine rocks a certain amount of jet has been obtained; but most of the well-known Whitby jet is of Upper Liassic age.

Another marine intercalation, the *Scarborough* or *Grey Limestone Series*, rests on the Middle Estuarine beds; these blue and grey limestones, exposed in the cliffs at Cloughton Wyke, form the most important marine development in the Yorkshire Oolites. Resting on the Scarborough limestones there is a third succession of freshwater strata, known as the *Upper Estuarine Series*, consisting of hard siliceous rocks, sandstones, shales, and ironstones, including much carbonaceous matter. Some species of plants have been obtained from sandstone strata in the lower part of this third Estuarine Series, which occupies nearly the whole of the moorlands of the East Yorkshire area.

At the summit of the Inferior Oolite we have the *Cornbrash*, so named by William Smith, which is made up of calcareous beds containing abundant marine fossils, and is exposed in the Cayton and Gristhorpe Bay sections.

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[1] Gregory (96), p. 159.

The conditions under which the estuarine sediments of the Yorkshire area were laid down are briefly dealt with in the concluding pages of the Catalogue. As the present volume deals only with the Inferior Oolite plants of East Yorkshire, the consideration of the Stonesfield flora and of other Oolitic plants recorded from various British localities is reserved for the second volume of the Jurassic Flora Catalogue.

JURASSIC PLANT-BEARING STRATA OF FRANCE, GERMANY, AND OTHER COUNTRIES.

The following incomplete account of extra-British Jurassic plant-bearing strata is intended to draw attention to the principal floras, which present a more or less close resemblance to that facies of Jurassic vegetation represented by the plants from the Yorkshire coast. In the following lists of plants the right-hand column is intended to illustrate the resemblance or possible identity of British species with species described from other countries; a more detailed comparison may be found in the descriptive part of the Catalogue.

FRANCE.

One of the earliest notices of French Jurassic plants occurs in a memoir by Desnoyers[1] on the Oolite rocks of Mamers in the department of Sarthe in the north-west of France, containing a few notes by Brongniart on some species of fossil plants.

Some years later Pomel[2] published a series of notes on Jurassic plants from several localities and horizons, and proposed a large number of new generic names, most of which have not been retained. A small number of species is enumerated also by Brongniart in his *Prodrome*[3] of 1828, and in the *Tableau*[4] published in 1849; but it is in the well-known volumes by Saporta[5] that we find

[1] Brongniart, in Desnoyers (24).
[2] Pomel (49).
[3] Brongniart (28^1), p. 198.
[4] Ibid. (49), p. 105.
[5] Saporta (73) (75) (84) (91).

the fullest account of the Jurassic plants of France. Some of the figures in Saporta's monograph are reproduced from drawings originally prepared for Brongniart, and these enable us to recognize certain species which are mentioned but not described in the *Prodrome* and the *Tableau*. Several of the specimens figured in Saporta's volumes are in the Museum of Natural History and in the School of Mines, Paris; an examination of some of the type-specimens impressed upon me the need of considerable caution in drawing conclusions from the figures alone, many of which are far from accurate. In the following list only such plants are included as present a close resemblance to East Yorkshire species, or agree approximately in age with the British species. Several species of *Sphenopteris*, *Scleropteris*, *Cladophlebis*, and other ferns have been omitted, as they are often founded on fragmentary and insufficient material. Most of the strata from which the Jurassic plants of France have been obtained are of marine origin. Among the most important localities from the point of view of a comparison of the French and English species are Mamers (Bathonian), D'Etrochey (Cornbrash), and Châteauroux (Corallian), in the departments of Sarthe, Côte d'Or, and Indre respectively. The numerous fossils referred by Saporta to Algæ need not be considered; they have no representatives in the Yorkshire beds, and most of them have in all probability no claim to be included in the plant kingdom.

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Equisetum Duvalii, Sap., p. 248, pl. 30, figs. 1–4 (Bathonian); cf. *Equisetites columnaris*, Brongn.

Sphenopteris Pellati, Sap., p. 278, pl. 31, fig. 1 (Kimmeridgian); cf. *Coniopteris hymenophylloides* (Brongn.).

Coniopteris conferta, Sap., p. 289, pl. 31, fig. 3 (Corallian); cf. *Coniopteris hymenophylloides* (Brongn.).

Microdictyon rutenicum, Sap., p. 309, pl. 33, figs. 2–4, and pl. 44 (Bathonian); cf. *Laccopteris Woodwardi* (Leck.).

M. Woodwardianum, Sap., p. 313, pl. 33, figs. 5–7 (Bathonian); = *Laccopteris Woodwardi* (Leck.).

Stachypteris litophylla, Sap., p. 387, pl. 50 (Corallian); cf. (pars) *Coniopteris quinqueloba* (Phill.).

Lomatopteris Moretiana, Sap., p. 396, pl. 51, figs. 4–6; pl. 52, figs. 1–5 (Bathonian). (Also other species of *Lomatopteris*, which do not appear to be represented in the East Yorkshire flora.)

Tæniopteris vittata, Brongn., p. 444, pl. 64, figs. 1–5 (Rhætic); = ? *T. vittata*.

Jeanpaulia longifolia (Pomel), p. 464, pl. 67, fig. 1 (Corallian); cf. *Baiera gracilis*.
J. obtusa, Sap., p. 466, pl. 67, fig. 2 (Corallian); cf. *B. gracilis*.
J. laciniata (Pom.), p. 467, pl. 67, fig. 3 (Corallian) } cf. *Baiera Lindleyana*.
J. flabelliformis (Pom.), p. 468, pl. 67, fig. 4 (Corallian) }

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Cycadites Delessei, Sap., p. 73, pl. 83, figs. 5–7 (Great Oolite).
Zamites Moreaui, Sap., ex Brongn. MS., p. 92, pl. 84, figs. 1–3, and pl. 85, pp. 1 and 2 (Corallian); cf. *Williamsonia gigas* (L. & H.) and *Otozamites acuminatus* (L. & H.).
Z. acerosus, Sap., p. 97, pl. 86 (Corallian); cf. *Otozamites acuminatus* (L. & H.).
Z. Feneonis, Brongn., p. 99, pls. 87–92 (Corallian and Kimeridgian); = (pars) *Williamsonia gigas* (L. & H.).
Z. Claravallensis, Sap., p. 108, pl. 93, fig. 1 (Kimeridgian); cf. *Williamsonia gigas* (L. & H.).
Z. Renevieri, Heer, p. 112, pl. 93, fig. 2; cf. *W. gigas*.
Z. distractus, Sap., p. 115, pl. 93, pp. 4 and 5 (Kimeridgian); cf. *Otozamites acuminatus* (L. & H.).
Otozamites recurrens, Sap., p. 146, pl. 101, figs. 2, 3 (Bathonian); = ? *Otozamites graphicus* (Leck.).
O. graphicus (Leck.), p. 153, pl. 102, pp. 2, 3 (Bathonian); = *O. graphicus* (Leck.).
O. Brongniartii, Schimp., p. 155, pl. 103, fig. 4 (Bathonian).
O. pterophylloides, Schimp., ex Brongn. MS., p. 157, pls. 104–108 (Bathonian); cf. *O. obtusus*, var. *ooliticus*.
O. microphyllus, Brongn., p. 166, pl. 108, fig. 2 (Bathonian).
O. marginatus, Sap., p. 168, pl. 109, fig. 1 (? Bathonian); = *Otozamites Beani* (L. & H.).
O. Reglei (Brongn.), p. 170, pl. 109, figs. 2–7 (Bathonian).
O. decorus, Sap., p. 177, pls. 110, 111 (Cornbrash); cf. *O. acuminatus* (L. & H.).
O. lagotis, Brongn., p. 179, pl. 110, fig. 2 (Bathonian).
Sphenozamites Brongniartii, Sap., p. 186, pl. 112, figs. 2–4 (Bathonian); cf. *Sewardia armata* (Sap.).[1]
S. Rossii, Zign., p. 191, pl. 114, figs. 1, 2 (Kimmeridgian); cf. *Otozamites Beani* (L. & H.).

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Trichopitys laciniata, Sap., p. 266, pl. 155, figs. 3–9 (Corallian); cf. *Baiera Lindleyana*.
Baiera longifolia (Pom.), p. 279, pl. 159, figs. 1, 2 (Corallian); cf. *B. gracilis*, Bunb.
Brachyphyllum Desnoyersii (Brongn.), p. 331, pls. 163, 164 (Cornbrash); cf. *Brachyphyllum mamillare*, Brongn.

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[1] A Wealden species; vide Zeiller (97), p. 58, and Seward (95), p. 153.

Brachyphyllum Moreauanum, Brongn., p. 341, pls. 165–168 (Corallian); cf. *B. mamillare.*

B. Jauberti, Sap., p. 349, pl. 165, figs. 1–4 (Corallian); cf. *B. mamillare.*

Pachyphyllum rigidum (Pom.), p. 391, pls. 177–179 (Corallian); cf. *Pagiophyllum Williamsoni* (Brongn.).

Araucarites Moreauana (Pom.), p. 425, pls. 184, 185 (Corallian); cf. *Araucarites Phillipsi*, Carr.

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Laccopteris Fabrei, Sap., p. 384, pl. 285, fig. 3 (Bathonian); =? *Laccopteris.* (The veins do not show any anastomoses; cf. *L. Daintreei.*)

Otozamites Bunburyanus, Zign., p. 460, pl. 298, fig. 1 (Bathonian); = *Otozamites Bunburyanus*, Zign.

A few species of Inferior Oolite plants have been recorded by Fliche & Bleicher[1] from strata in the neighbourhood of Nancy, but the fragments figured are too small to admit of accurate determination.

Additions have been made to the plants from French Jurassic strata by Crié, who records some new species from Mamers and other localities. This author has also published brief notes on the comparison of French Jurassic plants with species from England, Portugal, and the Southern Hemisphere.[2] A fern described by Zeiller as *Acrostichides rhombifolius*, var. *rarinervis*, Font., from the Grès bigarré of Saint-Germain bears a close resemblance to *Todites Williamsoni* from the English Oolitic rocks.[3]

GERMANY.

The chief developments of Jurassic rocks in Germany are referred by Kayser[4] to three principal areas:

1. *Franko-Swabian area*, forming a large curve, "one arm of which extends with a south-easterly strike from the region of Coburg to Regensburg, whilst the other stretches thence in a south-westerly direction to the foot of the Black Forest." The passage-beds between the Keuper and

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[1] Fliche & Bleicher (82).
[2] Crié (86) (87) (88).
[3] Zeiller (88).
[4] Kayser (95), p. 239.

Liassic rocks of the north arm of this area have afforded a particularly rich flora, which has been described in detail by Schenk [1]; this flora is referred to later.

2. *North-West Germany*; from Helmstedt and Quedlinburg to the Teutoberger Wald. Several Wealden species have been described from this region.[2]
3. *Upper Silesian Jura.* A belt thirty miles long, from Cracow to Kalisch.

Kurr [3] has described a few species of plants from the Swabian Jura, which suggest a Liassic horizon; a few of these may be compared with East Yorkshire species:

Zamites Mandelslohi, Kurr; cf. *Otozamites parallelus* (Phill.).
Zamites gracilis, Kurr; cf. small forms of *Williamsonia pecten* (Phill.).

From the Solenhofen beds in Franconia,[4] which are classed with the Upper or White Jura, several plants have been recorded, especially species of conifers.

The fossil flora of Bamberg, Bayreuth, and other localities in the Franconian area is one of the richest in Europe. Plants from these localities have been described by Sternberg, Göppert, Braun, and others, but it is to Schenk [5] that we owe the most complete account of this Rhætic-Lias flora. Attention has been called by Braun,[6] and more recently by Nathorst, to the close agreement or even identity of many of the Franconian plants with species of Lower Oolite age from East Yorkshire. The following list includes such species as illustrate most clearly the marked Lower Oolitic facies of the Keuper and Lias flora.

Equisetites Muensteri, Sternb.; cf. *E. columnaris*, Brongn.
Baiera tæniata, Braun; cf. *Baiera Phillipsi*, Nath. (Some of the examples of *B. tæniata* figured by Schenk are identical with Yorkshire specimens; e.g., cf. pl. ix. fig. 4 of the present volume, and Schenk's pl. v. fig. 2.)
Jeanpaulia Muensteriana (Presl); cf. *Baiera gracilis*, Bunb. (cf. pl. ix. fig. 3, and Schenk, pl. ix. figs. 7 and 10).

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[1] Schenk (67).
[2] Vide Seward (94), pp. xviii. et seq.
[3] Kurr (45).
[4] Unger (52); Thiselton-Dyer (72[1]) (72[2]), etc.
[5] Schenk (67).
[6] Braun (43).

Acrostichites Goeppertianus (Münst.); cf. *Todites Williamsoni* (Brongn.).
A. princeps (Presl) = *Sphenopteris princeps*, Presl.
Asplenites Roesserti (Presl); cf. *Cladophlebis denticulata* (Brongn.).
A. Ottonis (Göpp.); cf. *C. denticulata* (fertile pinnæ).
Sagenopteris rhoifolia, Presl; cf. *Sagenopteris Phillipsi* (Brongn.). (Cf. Text-figs. 24–26, and Schenk, pl. xii. fig. 1; also pl. xviii. fig. 2, and Schenk, pl. xiii. fig. 4.)
Phlebopteris affinis, Schenk; cf. *Laccopteris polypodioides* (Brongn.).
Thaumatopteris Münsteri, Göpp.
Dictyophyllum obtusilobum, Schenk } cf. *Dictyophyllum rugosum* (L. & H.).
D. acutilobum, Schenk
Clathropteris platyphylla, Brongn.; cf. *D. rugosum*.
Laccopteris elegans, Presl; cf. *Laccopteris Woodwardi* (Leck.).
Laccopteris Goepperti, Schenk } cf. *L. polypodioides* (Brongn.).
L. Muensteri, Schenk
Tæniopteris tenuinervis, Brauns } cf. *T. vittata*, Brongn.
T. stenoneura, Schenk
Nilssonia polymorpha, Schenk; cf. *Nilssonia compta* (Phill.). (Cf. pl. ix. fig. 5; and Schenk, pl. xxix. fig. 11, and pl. xxx. fig. 4.)
Zamites distans, Presl; cf. *Podozamites lanceolatus*.
Pterophyllum Carnallianum, Göpp. } cf. *Dioonites*.
P. Braunianum, Göpp.
P. inconstans, Göpp.; cf. *Anomozamites Nilssoni* (L. & H.).
Brachyphyllum Muensteri, Schenk; cf. *Cheirolepis setosus* (Phill.).

AUSTRIA.

Jurassic plants are poorly represented in the Austrian Empire. The well-known floras of Lunz in Lower Austria and Raibl in Carinthia belong to an earlier epoch, and present but few points of contact with the Lower Oolite flora of England.

From Steierdorf in Banat in the south-eastern part of Hungary, Ettingshausen[1] described a few plants in 1852; but this flora has been more fully dealt with by Andrae,[2] who recognized nine species as identical with Lower Oolite types from the Yorkshire coast. As a few only of Andrae's plants are figured it is impossible to express any opinion as to the identity of some of the species with Lower Oolite types.

Equisetites lateralis, Phill. = ? *E. columnaris*, Brongn.
Cyclopteris digitata = *Ginkgo digitata* (Brongn.).
Sphenopteris obtusifolia, And.; cf. *Todites Williamsoni* (Brongn.).

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[1] Ettingshausen (52). [2] Andrae (55).

Alethopteris Phillipsii (Brongn.) } = ? *Cladophlebis denticulata* (Brongn.).
A. dentata (L. & H.) }
Cyatheites decurrens, And.; cf. *Klukia exilis* (Phill.) and *Coniopteris arguta* (L. & H.).
Polypodites crenifolius (Phill.) = *Laccopteris polypodioides* (Brongn.).
Camptopteris Nilssoni (Brongn.); cf. *Dictyophyllum rugosum*, L. & H.
Pecopteris Murrayana, Brongn. = ? *Coniopteris hymenophylloides* (Brongn.).
Andriania baruthina, Braun; cf. *Laccopteris polypodioides* (Brongn.).
Tæniopteris vittata, Brongn.
Zamites Schmiedelii (Sternb.) = *Williamsonia gigas* (L. & H.).
Z. gracilis, Kurr } cf. *W. pecten* (Phill.).
Pterophyllum rigidum, Göpp. }
Protorhipis Buchii, And.[1]

In 1888 Stur[2] described several species of Jurassic plants from Grojec in Galicia, and more recently Raciborski[3] has published an important memoir on the fossil flora of the Cracow district obtained from the mines of Grojec and other localities. Many of Raciborski's species are undoubtedly identical with East Yorkshire plants; and the flora as a whole presents a closer agreement with that of the Inferior Oolite than with any other period. Raciborski recognizes the correspondence between the Cracow plants and those from the Yorkshire coast, but from the presence of *Thinnfeldia* and some other Rhætic types he concludes that the flora he describes is slightly older than the English flora.

The following list, which does not include all the species, illustrates the striking Lower Oolite facies of the Cracow flora:—

Danaea microphylla, Rac.
Todea Williamsonis (Brongn.) = *Todites Williamsoni* (Brongn.).
T. princeps (Presl). (Raciborski's figures do not afford satisfactory evidence of the occurrence of this species.)
Klukia exilis (Phill.) }
K. acutifolia, Rac. } = *K. exilis* (Phill.).
K. Phillipsii, Rac. }
Dicksonia Heerii, Rac. = *Coniopteris hymenophylloides* (Brongn.).
D. lobifolia (Phill.) = *Cladophlebis lobifolia* (Phill.).
Thyrsopteris ? *Murrayana* (Brongn.) = *Coniopteris hymenophylloides* (Brongn.).
Laccopteris Phillipsii, Zign. = ? *Matonidium Goepperti* (Ett.).
Microdictyon Woodwardii (Leck.) = *Laccopteris Woodwardi* (Leck.).
Hymenophyllites ? *Zeilleri*, Rac.; cf. *Ruffordia Goepperti* (Dunk.).

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[1] Vide also Zeiller (97), pl. xxi. p. 51.
[2] Stur (88[2]).
[3] Raciborski (94).

Ctenis asplenioides (Ett.)
C. Potockii, Stur } cf. *Ctenis*, sp.
C. Zeuschneri, Rac.

Thinnfeldia haiburnensis (L. & H.); cf. *Cladophlebis haiburnensis* (L. & H.).

Tæniopteris cf. *stenoneuron*, Schenk } cf. *Tæniopteris vittata*, Brongn.
T. cf. *vittata*, Brongn.

Sagenopteris Phillipsii (Brongn.) } cf. *Sagenopteris Phillipsi* (Brongn.).
S. Goeppertiana, Zign.

Cladophlebis whitbiensis, Brongn.) } *Todites Williamsoni* (Brongn.).
C. solida, Rac.

C. insignis (L. & H.) = *Cladophlebis denticulata* (Brongn.).

Pecopteris decurrens (Andrae); cf. *Coniopteris arguta* (L. & H.).

Two species of coniferous wood have been described by Felix from Galicia, which he names *Cormocedroxylon jurense* and *Cladocedroxylon Auerbachii*, from the Braun Jura and Lower Kimeridgian respectively.[1]

ITALY.

By far the most important contribution to the Mesozoic Botany of Italy is that by Zigno, published in parts between 1856 and 1885.[2] In a preliminary paper published in 1853, Zigno[3] drew attention to the close similarity of the recently discovered Lower Oolite (Bathonian) plants of the Venetian Alps with those from East Yorkshire. Among the Italian plants the following may be mentioned as nearly allied to or identical with British Inferior Oolite species; the Venetian flora is rich in Cycads, the genus *Otozamites* being especially well represented.

Phyllotheca Brongniartiana, Zign. } Not represented in the English flora.
P. equisetiformis, Zign.

Equisetites Bunburyanus, Zign. } cf. *Equisetites columnaris*, Brongn.
E. Veronensis, Zign.

Hymenophyllites Leckenbyi, Zign. Some of the figures resemble fertile pinnæ of the *Tympanophora racemosa* type (*Coniopteris hymenophylloides*).

Dichopteris Visianica, Zign.; cf. *Pachypteris lanceolata*.

D. microphylla, Zign. = ? *Todites Williamsoni* (Brongn.).

Cycadopteris (four species).

Polypodites undans (L. & H.) = *Cladophlebis denticulata* (Brongn.) (fertile frond).

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[1] Felix (82), p. 265, pl. ii. fig. 5.
[2] Zigno (56–85).
[3] Ibid. (53).

Marzaria Paroliniana, Zign. = ? *Laccopteris* (young frond).
Phlebopteris polypodioides } = *Laccopteris polypodioides* (Brongn.).
P. contigua }
Sagenopteris cuneata, L. & H. = *Sagenopteris Phillipsi* (Brongn.), var. *cuneata*.
S. reniformis, Zign.; cf. *S. Phillipsi*, var. *cuneata*.
S. Goeppertiana, Zign.; cf. *S. Phillipsi*, var. *major*.
Laccopteris Rotzana, Zign.; cf. *Laccopteris polypodioides*.
Danaeites Heerii, Zign.; cf. large examples of *Nilssonia compta* (Phill.).
Zamites Rotzoanus, Zign.; cf. *Williamsonia pecten* (Phill.).
Ptilophyllum grandifolium, Zign. }
Otozamites Mathellianus, Zign. } cf. *Otozamites parallelus*, Phill.
O. Nathorsti, Zign. }
O. Vicetinus, Zign.; cf. *O. graphicus* (Leck.).
O. Massalongianus, Zign. } = *O. Feistmanteli*, Zign.
O. Feistmantelii, Zign. }
O. Molinianus, Zign. }
O. Canossæ, Zign. }
O. Trevisani, Zign. } Cf. *O. Beani* (L. & H.).
Sphenozamites (three species) }
Otozamites Bunburyanus, Zign. = *O. Bunburyanus*, Zign.
Blastolepis otozamites, Zign. }
B. acuminata, Zign. } = *Williamsonia*, sp.
B. falcata, Zign. }

SWITZERLAND.

The species which Heer refers to a Jurassic horizon in his *Flora Fossilis Helvetiæ*[1] are few in number, and in several instances too fragmentary to admit of determination. The numerous specimens classed among the Algæ are practically valueless for our present purpose.

Sagenopteris Charpentieri, Heer (Lias); cf. *Sagenopteris Phillipsi*.
Zamites formosus, Heer = *Williamsonia gigas* (L. & H.).
Z. Feneonis, Brongn. (Kimeridgian) = ? *W. gigas*.
Phlebopteris affinis, Schenk (Lias); cf. *Laccopteris polypodioides* (Brongn.).

PORTUGAL.

Most of the Mesozoic plants recorded from Portugal may be identified or compared with Wealden species, or with plants from higher horizons in the Cretaceous system. Both Heer[2] and

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[1] Heer (76), vide also Heer (65).
[2] Heer (81).

Saporta[1] have described several species of plants from strata of Jurassic age, some of which are probably identical with English species. Several of the 'species' founded by Saporta on extremely small fragments possess but little value as definite specific types, and it is impossible to form any accurate estimate of the number of East Yorkshire types which may be represented in the Portuguese flora of Jurassic age.

Equisetum lusitanicum, Heer, figured by Heer and Saporta, may be identical with *Equisetites columnaris*, and *Otozamites angustifolius*, Heer, agrees fairly closely with some of the English examples of *Williamsonia pecten* (Phill.); among the fragments referred by Saporta to *Sphenopteris* there are some which recall *Coniopteris hymenophylloides* and *C. quinqueloba*; but it is useless to attempt to base any detailed comparisons on such imperfect data.

SCANDINAVIA.

The Rhætic flora of Scania, in Southern Sweden, contains several species which are closely allied to Lower Oolite types. Nathorst's memoirs on the plants from Pålsjö, Bjuf, Helsingborg, and other localities in Scania, are among the most important contributions to our knowledge of Lower Mesozoic floras, and they enable us to obtain a fairly comprehensive view of the characteristics of Rhætic vegetation. Nathorst has himself drawn attention to the numerous points of contact between the Rhætic flora of Sweden and the later flora of East Yorkshire.[2] The following list includes such species from Nathorst's lists as best illustrate the existence of a Lower Oolite facies in the Swedish flora; for further information regarding the Scanian plants reference must be made to Nathorst's memoirs, from which the following species have been selected:—[3]

Rhizomopteris Schenki, Nath. Not represented in the British flora, but worthy of note as possibly the rhizome of *Dictyophyllum*.

Cladophlebis nebbensis (Brongn.)
C. Heeri, Nath.
Asplenites, sp.
} cf. *Cladophlebis denticulata* (Brongn.).

[1] Saporta (94), vide also Sharpe (50).

[2] Nathorst (80), p. 82.

[3] Nathorst (78[1]) (78[2]) (78–86).

Dictyophyllum Nilssoni (Brongn.) } cf. *Dictyophyllum rugosum*, L. & H.
D. Muensteri (Göpp.) }
Sagenopteris alata, Nath. } cf. *Sagenopteris Phillipsi* (Brongn.).
S. rhoifolia, Presl }
S. undulata, Nath. (Possibly not a distinct species.) }
Nilssonia polymorpha, Schenk; cf. *Nilssonia compta* (Phill.).
Anomozamites gracilis, Nath.; cf. *Anomozamites Nilssoni.*
Podozamites distans (Presl); cf. *Podozamites lanceolatus.*
P. lanceolatus (L. & H.) = *P. lanceolatus* (L. & H.).
Baiera Geinitzi, Nath.; cf. *Ginkgo digitata* (Brongn.) and *G. whitbiensis*, Nath.
Palissya Braunii, Endl.; cf. *Taxites zamioides* (Leck.).
Lepidopteris Ottonis (Göpp.) (= *Asplenites Ottonis*, Schenk); cf. *Cladophlebis denticulata* (fertile pinna).
Ctenis fallax, Nath. (= *Anthrophyopsis Nilssoni*, Nath.); cf. *Ctenis*, sp.
Ptilozamites Nilssoni, Nath.; cf. *Ptilozamites Leckenbyi.*
Acrostichites Goeppertianus (Münst.); cf. *Todites Williamsoni* (Brongn.).
Tæniopteris obtusa, Nath. } cf. *Tæniopteris vittata*, Brongn.
T. tenuinervis, Braun }
Ginkgo minuta, Nath.
Baiera paucipartita, Nath.; cf. *Baiera Phillipsi*, Nath.
Czekanowskia rigida (Heer); cf. *Czekanowskia Murrayana* (L. & H.).

Some of the Rhætic plants from Scania comparable with Jurassic species are figured by Nathorst in his *Geology of Sweden.*[1]

BORNHOLM.

Jurassic plants from Bornholm have long been known through the description of a few species by Pingel, Brongniart, Forchhammer, and Nathorst, but it is only recently that any complete account of the fossil flora of this island has been attempted. Bartholin's investigations[2] clearly demonstrate the occurrence of several Inferior Oolite species in the Bornholm fossil flora; he concludes that rather less than half of the species are identical with or closely allied to Rhætic plants, while about one-third agree with Inferior Oolite types. The species enumerated below afford strong evidence in favour of the existence of a well-marked Oolitic facies in the Bornholm flora; in fact, I am disposed to consider that the Inferior Oolite types predominate over the Rhætic and Wealden species.

Sagenopteris Phillipsii (Brongn.) = *S. Phillipsi.*
Dicksonia Pingelii (Brongn.); cf. (pars) *Coniopteris hymenophylloides* (Brongn.).
Asplenium Roesserti (Presl); cf. *Cladophlebis denticulata* (Brongn.).

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[1] Nathorst (92). [2] Bartholin (92) (94).

Asplenium lobifolium (Phill.) = *Cladophlebis lobifolia* (Phill.).
Laccopteris elegans, Presl; cf. *Laccopteris polypodioides* (Brongn.).
Tæniopteris tenuinervis, Braun; cf. *T. vittata*, Brongn.
Microdictyon Woodwardianum, Sap. = *Laccopteris Woodwardi* (Leck.).
Dictyophyllum Nilssoni (Brongn.) = ? *D. rugosum* (L. & H.).
Anthrophyopsis Nilssoni, Nath.; cf. *Ctenis*, sp.
Podozamites lanceolatus (L. & H.) = *P. lanceolatus* (L. & H.).
Nilssonia polymorpha, Schenk (pars) = ? *N. tenuinervis*, Nath.
Otozamites obtusus (L. & H.).
O. Reglei (Brongn.).
Ginkgo digitata (Brongn.) }
G. Huttoni, Heer } = *G. digitata* (Brongn.).
Czekanowskia rigida, Heer; cf. *Baiera Lindleyana* (Schimp.).
Pagiophyllum falcatum, Barth.; cf. *P. Williamsoni* (Brongn.).

DENMARK.

Bartholin[1] has recently figured and described some plant fragments found in an erratic block of ferruginous sandstone from the glacial deposits near Copenhagen. The specimens are for the most part very imperfect, and their determination is a matter of some uncertainty, but one or two of the species are represented by more satisfactory examples:—

Ginkgo Huttoni = *G. digitata*, Brongn.
Podozamites lanceolatus intermedius, Heer }
P. angustifolius (Eich.) } = ? *Podozamites lanceolatus* (L. & H.).
Oleandridium vittatum = *Tæniopteris vittata*, Brongn.

ARCTIC REGIONS AND RUSSIA.

1. SPITZBERGEN.

In 1872 Nordenskiöld and Oberg obtained a collection of Jurassic plants from Cape Boheman (lat. 78° 22′ N.), which have been described by Heer[2] and lately revised by Nathorst.[3] This flora, consisting of a small number of species, is no doubt approximately of the same age as that from the East Yorkshire strata.

Sphenopteris thulensis, Heer; cf. *Coniopteris hymenophylloides* (Brongn.).
Pecopteris exilis, Phill. (fragment too small to determine) = ? *Klukia exilis* (Phill.).
Tæniopteris, sp.; cf. *T. vittata*, Brongn.

[1] Bartholin (97). [2] Heer (77[1]), p. 26. [3] Nathorst (97).

Anomozamites bifida (Heer) = ? *Nilssonia tenuinervis*, Nath.
Equisetites, sp.; cf. *Equisetites columnaris*, Brongn.
Podozamites lanceolatus (L. & H.) = ? *Podozamites lanceolatus*.
Ginkgo digitata (Brongn.)
G. Huttoni (Sternberg) } = *Ginkgo digitata* (Brongn.).
G. integriuscula, Heer
Pinus prodromus, Heer; cf. *Czekanowskia Murrayana* (L. & H.).
Stenorrachis striolatus (Heer); cf. *Ginkgo*, sp. (male flower).

A few plants which suggest the same geological horizon as that of the Cape Boheman beds have been described also from Sassen Bay; the specimens referred by Nathorst to *Nilssonia* cf. *orientalis*, Heer, may be compared with the English species *N. tenuinervis*, Nath.

The Mesozoic plants obtained from Advent Bay and Cape Staratschin in Spitzbergen belong to a somewhat higher horizon, and bear a close resemblance to Wealden types; they are probably of uppermost Jurassic age.[1]

In a paper published in 1890 Schenk[2] describes a species of *Araucarioxylon* and two species of *Cedroxylon* from the plant-beds of Green Harbour; the specimens were originally described by Cramer under the generic name *Pinites*.[3]

2. Siberia.

Among the Mesozoic floras of the far North the most important, from the point of view of the distribution of Lower Oolite species, is that which Heer has described from material collected by Czekanowski, Hartung, and others. The principal localities at which these Jurassic plants were discovered are Ust-Balei, in latitude 51° N., about forty miles north of Irkutsk, the Upper Amoor River, the Lena district, and elsewhere.[4]

Thyrsopteris Murrayana (Brongn.)
T. Maakiana, Heer } = ? *Coniopteris hymenophylloides* (Brongn.).
Dicksonia clavipes, Heer
D. arctica, Heer
Asplenium whitbiense (Brongn.) = *Todites Williamsoni* (Brongn.) and (pars) ? *Cladophlebis denticulata* (Brongn.).

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1 Vide Heer and Nathorst, loc. cit.
2 Schenk (90).
3 Cramer, in Heer (68).
4 Heer (77[2]) (78) (83[1]).

A. argutulum, Heer
A. distans, Heer } cf. *C. denticulata* (Brongn.).
A. Petruschinense, Heer
Phyllotheca Sibirica, Heer; cf. *Equisetites columnaris*, Brongn.
Podozamites (several species founded on small fragments); cf. *Podozamites lanceolatus* (L. & H.).
Baiera longifolia (Pomel)
Ginkgo lepida, Heer } cf. *Baiera Phillipsi*, Nath.
B. Czekanowskiana, Heer; cf. *B. gracilis*, Bunb.
Several forms of *Ginkgo* leaves, including numerous examples of *G. digitata* referred by Heer to various species; a few specimens resemble *G. whitbiensis*, Nath.
Trichopitys setacea, Heer; cf. *Baiera Lindleyana* (Schimp.).
Czekanowskia rigida, Heer
C. setacea, Heer } = (pars) *Czekanowskia Murrayana* (L. & H.).
Anomozamites angulatus, Heer; cf. *Nilssonia compta* (Phill.).
Anomozamites Lindleyanus, Schimp. = *Anomozamites Nilssoni*.

In 1879 and 1881 Schmalhausen[1] published a memoir on the Jura-Flora of Russia, in which he described plants from the coal-basin of Kusnezk in the Altai Mountains, in West Siberia, from the valley of the Petschora River in North-East European Russia, and from the lower Tunguska River in Northern Siberia. From these regions he recorded certain species of plants indicative of a Jurassic age, such as *Ginkgo digitata*, *Czekanowskia rigida*, *Thyrsopteris prisca*, Heer, and other ferns. It is, however, very probable, as Zeiller[2] has shown, that these plant-beds should be referred to a Permian horizon. The reasons for this conclusion and the correctness of Schmalhausen's determinations are discussed at length in Zeiller's paper.

Eichwald[3] has recorded a few Jurassic plants from Kamenka and other localities in Southern Russia:—

Alethopteris insignis = ? *Cladophlebis denticulata* (Brongn.).
Tæniopteris vittata = *T. vittata*, Brongn.
Zamites lanceolatus = *Podozamites lanceolatus* (L. & H.).
Cyclopteris incisa, Eich. = ? *Ginkgo digitata* (Brongn.).
Sphenopteris prisca, Eich.; cf. *Coniopteris hymenophylloides* (Brongn.).

From Disco Island and from Kome on the north-west coast of Greenland, Heer[4] has described numerous species, which indicate

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[1] Schmalhausen (79) (81).
[2] Zeiller (96).
[3] Eichwald (68), p. 15.
[4] Heer (75) (83^2).

on the whole a Cretaceous rather than a Jurassic flora; some types, however, are identical with or closely allied to East Yorkshire species.

Zamites speciosus, Heer; cf. *Williamsonia pecten* (Phill.).
Nilssonia Johnstrupi, Heer; cf. *Tæniopteris major*, L. & H.
Ginkgo multinervis, Heer; cf. *G. digitata* (Brongn.).
Pteris frigida, Heer = *Cladophlebis denticulata* (Brongn.).

In 1896 Dr. Hartz,[1] of Copenhagen, published a description of eighteen species of fossil plants from Cape Stewart on the east coast of Greenland; he considers the flora to be of Rhætic or Rhætic-Lias age, but he expresses his opinion cautiously, and points out that the evidence is hardly sufficient to admit of accurate determination of the geological horizon. Some of Hartz' plants are no doubt identical with Inferior Oolite species.

Cladophlebis Roesserti Groendlandica; cf. *C. denticulata* (Brongn.).
C. Stewartiana, Hartz; *Asplenites*, sp. (fertile pinna) = ? *C. denticulata*.
Todea Williamsonis (Brongn.) = *Todites Williamsoni* (Brongn.).
Pterophyllum subæquale, Hartz; cf. *Williamsonia pecten* (Phill.).
Podozamites lanceolatus (L. & H.); *P. Schenkii*, Hartz = *P. lanceolatus*.
Czekanowskia rigida, Heer; *C. setacea*, Heer = *Czekanowskia Murrayana* (L. & H.).

3. Franz Josef Land.

A few somewhat fragmentary plants have been collected by Nansen[2] and by the members of the Jackson-Harmsworth expedition[3] on the north side of Cape Flora, which suggest a comparison with members of the Inferior Oolite flora of England; but the specimens are hardly numerous enough and sufficiently well preserved to afford certain evidence of geological age.

The plants obtained by Nansen were examined by Nathorst,[4] and compared by him with the Upper Jurassic flora of Spitzbergen. Among the specimens mentioned by Nathorst the most interesting is a leaf of *Ginkgo*, very similar to some of the smaller examples

[1] Hartz (96).
[2] Nansen (97), p. 484.
[3] Newton & Teall (97), p. 493, pl. xxxviii.
[4] Nathorst, in Nansen (97), vol. ii. p. 484.

of *G. digitata* (Brongn.), from the Yorkshire coast, which is referred to a new species, *G. polaris*, Nath.; this might perhaps be designated *G. digitata*, var. *polaris*. Some of the Jackson-Harmsworth plants have been figured in a recent paper by Newton & Teall.[1] The specimens described by the latter authors are referred to the genera *Ginkgo*, *Thyrsopteris*, *Baiera*?, *Fieldenia*?, *Podozamites*?; but the material is insufficient to enable us to do more than express the opinion that the Cape Flora beds may be best compared with Oolitic or Wealden strata of other regions.

Messrs. Newton & Teall have also described some plant remains from Cape Stephen, about twenty miles west of Cape Flora, which they compare with Schmalhausen's species from Petschora and Tunguska. It is very probable that these Franz Josef plants may, like Schmalhausen's, be referred to a Permian horizon.

NORTH AMERICA.

1. United States.

Fontaine's monograph on the older Mesozoic flora of Virginia contains several illustrations which forcibly recall Lower Oolite plants. It is to be regretted that the drawings of the fossils have not been executed in more detail; they are often too sketchy, and presumably somewhat inaccurate, to enable one to feel much confidence in the nature of the plants represented. Fontaine thus concludes the discussion on the age and affinities of the flora:—"European authors, and especially Schimper, often call attention to the strong resemblance between the Rhætic and Lower Jurassic floras, the likeness to the Lower Oolite of England being especially striking. In accordance with this fact, the presence of a marked Jurassic element in the flora of these Mesozoic beds, both in Carolina and Virginia, is of itself an evidence that they cannot be older than Rhætic. We are, then, I think, entitled to consider that the older Mesozoic flora of North Carolina and Virginia is most probably Rhætic in age, and certainly not older."[2]

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[1] Newton & Teall, loc. cit. p. 503, pl. xli.
[2] Fontaine (83), p. 128.

Stur[1] has pointed out the close similarity between the Lunz flora of Austria and the Rhætic flora of Virginia. Perhaps the most striking example of a type identical with, or at least very nearly allied to, a Lower Oolite species is afforded by some fronds referred by Fontaine to the genus *Acrostichites*. In his description of plants from Virginia, Bunbury[2] expressed the view that as regards the evidence afforded by the fossil plants the strata might be referred with almost equal plausibility to either the Triassic or Jurassic series.

Equisetites Rogersi, Schimp. (considered by Rogers identical with *E. columnaris* from Brora in Sutherlandshire[3]); cf. *Equisetites columnaris*, Brongn.
Macrotæniopteris magnifolia, Rog.; cf. *Tæniopteris major*, L. & H.
Acrostichites linnææfolia, Rog.
A. rhombifolius, Font.
A. densifolius, Font.
Cladophlebis microphylla, Font.
} cf. *Todites Williamsoni* (Brongn.).
Podozamites Emmonsi, Font.; cf. *P. lanceolatus* (L. & H.).
Ctenophyllum Braunianum, Göpp.; cf. *Dioonites* sp.
Asterocarpus virginiensis, Font. (fertile fragment); cf. *Cladophlebis denticulata* (Brongn.).

The numerous plants described by Fontaine in a later monograph on the Potomac or younger Mesozoic flora[4] consist for the most part of Wealden and other Lower Cretaceous species, but Jurassic forms are also represented.[5] The 'Potomac flora' of Virginia and Maryland is in reality made up of floras varying in age from Upper Jurassic to the upper members of the Lower Cretaceous, and does not represent a single flora marking one definite geological horizon. It is unnecessary to attempt a detailed analysis of the species described by Fontaine. Several of the plants agree with European Wealden types, others point to a higher horizon, and there are a certain number which may be compared with Lower Oolite species. It is very difficult to institute any exact comparison between the Virginian and the East Yorkshire plants without access to the specimens themselves; the illustrations in Fontaine's monograph hardly do justice to the rich material, and the excessive

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[1] Stur (88[1]).
[2] Bunbury (47), p. 288.
[3] Fontaine (83), p. 12.
[4] Fontaine (89).
[5] Vide also Ward (95) (96) (97), and Marsh (98).

number of new specific names tends to confusion and misleading conclusions.

Cladophlebis virginiensis, Font. *C. denticulata*, Font. *C. falcata*, Font. (and other species)	The two species *Cladophlebis denticulata* (Brongn.) and *Todites Williamsoni* (Brongn.) are, I believe, represented among the Potomac ferns.
Asplenopteris adiantifolia, Font. *Aspidium macrocarpum*, Font.	cf. *Coniopteris hymenophylloides* (Brongn.) (fertile pinnæ). This species is probably represented by some of the fronds referred by Fontaine, on insufficient evidence, to *Thyrsopteris*.

Scleropteris elliptica, Font.; cf. *Pachypteris lanceolata.*
Platypterigium densinerve, Font.; cf. *Nilssonia compta* (Phill.).
Ctenopteris insignis, Font.; cf. *Ptilozamites.*
Nageiopsis microphylla; cf. *N. anglica.*
Cephalotaxopsis (several species); cf. *Taxites zamioides* (Leck., ex Bean MS.).
Williamsonia virginiensis, Font.; cf. *Williamsonia gigas* (L. & H.).

In 1896 Fontaine[1] published a list of fossil plants from California which he identified as probably Lower Oolite species; these include species of the genera *Cladophlebis* and *Thyrsopteris*, also ? *Sagenopteris rhoifolia*, *Pachyphyllum Williamsonis*, *Podozamites lanceolatus*, species of *Ctenophyllum* and *Ctenis.*

One or two species, comparable with Lower Oolite forms, have also been described by Newberry[2] from Triassic rocks of New Jersey and the Connecticut Valley.

2. Canada.

The plant-bearing strata of Canada have afforded but few species which may be considered identical with European Jurassic forms; but some of the plants obtained from the strata in the Rocky Mountains, named by Dr. G. M. Dawson the Kootanie Series, appear to be very closely allied to Lower Oolite species. Sir William Dawson has drawn attention to the presence of certain types in the Kootanie flora, which recall species described by Heer from Jurassic rocks of Siberia.[3]

Cladophlebis falcata, Font.; cf. *C. denticulata* (Brongn.).
Leptostrobus longifolius, Font.
Pinus suskwaensis, Daws. } = ? *Czekanowskia Murrayana* (L. & H.).

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[1] Fontaine (96).
[2] Newberry (88).
[3] Dawson (85) (92).

Salisburia sibirica, Heer } cf. *Ginkgo digitata* (Brongn.) and *Baiera Phillipsi*,
S. lepida, Heer } Nath.
Podozamites lanceolatus = ? *P. lanceolatus* (L. & H.).

PERSIA.

Several species of plants have been described by Göppert, Eichwald, Schenk, and Krasser from various localities in Persia; the flora is considered by Schenk to point to a Rhætic age;[1] but the general facies of the vegetation bears a distinct resemblance to the Lower Oolite[2] flora of East Yorkshire. It is not an easy matter to decide between a Rhætic and Inferior Oolite age when we have but a few fossil plant species as evidence; the close agreement between many of the elements of these two floras renders their separation a matter of difficulty when the material is not very abundant. Whether or not the Persian plant-beds belong to a Rhætic horizon, there are at least certain species in close agreement with Lower Oolite types.

Asplenium Roesserti; cf. *Cladophlebis denticulata* (Brongn.). There is an especially close resemblance between some of the large pinnules figured by Schenk and those of similar form from East Yorkshire.
Ctenozamites cycadea, Nath.; cf. *Ptilozamites Leckenbyi*.
Dictyophyllum acutilobum, Schenk; cf. *Dictyophyllum rugosum*, L. & H.
Oleandridium tenuinerve; cf. *Tæniopteris vittata*, Brongn.
Pterophyllum Braunianum, Göpp.; cf. *Williamsonia pecten* (Phill.).
Podozamites lanceolatus = ? *P. lanceolatus* (L. & H.).
Nilssonia polymorpha } cf. *Nilssonia compta* (Phill.).
N. compta }
Ginkgo Muensteriana; cf. *Baiera gracilis*, Bunb., and *B. Phillipsi*, Nath.
Acrostichites Williamsonis[3] = *Todites Williamsoni* (Brongn.).
Zamites approximatus, Eich.[3]; cf. *Otozamites*.

SOUTH AMERICA.

Among the Rhætic plants described from South America by Szajnocha[4] (Argentine Republic) and by Zeiller[5] and Solms-Laubach[6] (Chili), there are some species comparable with British

[1] Schenk (87), Krasser (91).
[2] Eichwald (68), p. 18.
[3] Eichwald (68), pl. ii. figs. 3, 8.
[4] Szajnocha (88).
[5] Zeiller (75).
[6] Solms-Laubach (99).

Lower Oolite types; these are referred to later under the genera *Baiera* and *Podozamites*.

CHINA.

Among the Mesozoic plants recorded from China there are some species which appear to be identical with Lower Oolite forms. Our knowledge of the fossil flora of China is based chiefly on the work of Newberry,[1] Brongniart,[2] and Schenk.[3]

Podozamites lanceolatus (L. & H.) = ? *P. lanceolatus* (L. & H.).
Pterozamites sinensis, Newb.; cf. *Williamsonia pecten* (L. & H.).
Sphenopteris orientalis, Newb. } = ? *Coniopteris hymenophylloides* (Brongn.).
Hymenophyllites tenellus, Newb. }
Pecopteris whitbiensis, Brongn.; cf. *Todites Williamsoni* (Brongn.).
Asplenium argutulum, Heer; cf. *Cladophlebis denticulata* (Brongn.).
Czekanowskia rigida, Heer. (Fragments too small to determine.)
Dicksonia coriacea, Schenk; cf. *Coniopteris hymenophylloides* (Brongn.).
Baiera angustiloba, Heer; cf. *Baiera gracilis*, Bunb.
Oleandridium eurychoron, Schenk; cf. *Tæniopteris vittata*.
Lycopodites Williamsoni = ? *Pagiophyllum Williamsoni* (Brongn.).
Anomozamites Lóczyi, Schenk; cf. *Anomozamites Nilssoni*, Schimp.
Dictyophyllum acutilobum;[4] cf. *D. rugosum*, L. & H.

JAPAN.

Geyler,[5] Nathorst,[6] and Yokoyama[7] have described several species of Mesozoic plants from Japan, some of which appear to be of Wealden age,[8] while others from Central Japan indicate an Inferior Oolite flora similar to that of East Yorkshire.

Dicksonia nephrocarpa, Bunb. (small fragments) = ? *Coniopteris hymenophylloides* (Brongn.).
Pecopteris exilis, Phill.; cf. *Coniopteris arguta* (L. & H.) and *Klukia exilis* (Phill.).[9]
Asplenium whitbiense (Brongn.) } cf. *Cladophlebis denticulata* (Brongn.).
A. distans, Heer }

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[1] Newberry (67).
[2] Brongniart, in David (74).
[3] Schenk (83) (85).
[4] Vide Schenk (85), p. 165; determined by M. Zeiller.
[5] Geyler (77).
[6] Nathorst (90[2]).
[7] Yokoyama (89) (94).
[8] Cf. also *Cladophlebis Dunkeri* (Schimp.).
[9] Seward (94[2]), p. 101.

Podozamites lanceolatus (L. & H.) = ? *Podozamites lanceolatus* (L. & H.).
Nilssonia nipponensis, Yok.; cf. *N. compta* (Phill.).
Sagenopteris, sp.; cf. *S. Phillipsi* (Brongn.).
Ginkgo digitata (Brongn.) = *Ginkgo digitata* (Brongn.).
G. cf. *lepida*, Heer; cf. *Baiera Phillipsi*, Nath.
Nilssonia orientalis, Heer; cf. *Tæniopteris vittata*, Brongn.

INDIA.

It has long been recognized that some of the Upper Gondwana floras of India present several features in common with European Jurassic floras. Feistmantel and others have identified various plants of the Kach and other Indian floras with Lower Oolite species from East Yorkshire, but it is very probable that the correspondence between these widely separated floras has been rather underestimated than exaggerated. Fossil plants of the Kach (Umia) flora were first described by Morris[1] in Captain Grant's *Geology of Cutch*, published in 1840, and in more recent years numerous species have been described by Feistmantel[2] and others.[3] The Jabalpur flora, so called from the town of Jabalpur, also contains several elements of a marked Lower Oolite facies. Both the Jabalpur and the Umia floras appear to be approximately of the same age; in the recent edition of the *Geology of India*[4] the latter is compared with the Middle and the former with the Upper Oolite. Several species of the Rajmahal flora also bear a striking resemblance to East Yorkshire types; this flora has been referred to the Liassic period.

In the following list are included such species as appear to be identical with or at least closely allied to British Inferior Oolite types; a more detailed comparison is made in several instances in the descriptive part of the Catalogue:—

Macrotæniopteris ovata, Schimp. (= *Tæniopteris ovalis*, L. & H., as identified by Oldham & Morris) = ? *Tæniopteris major*, L. & H.
Tæniopteris lata, O. & M.; cf. the smaller forms with *T. major*.
Oleandridium vittatum (Brongn.) = ? *Tæniopteris vittata*, Brongn.

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[1] Morris (40).
[2] Feistmantel (76) (77) (79) (80) (81).
[3] Oldham & Morris (63).
[4] Oldham, R. D. (93); vide also Blanford (75).

Angiopteridium spathulatum (McClell.); cf. *T. vittata.*
Pterophyllum princeps, O. & M.; cf. the larger forms of *Nilssonia compta* (Phill.).
Palæozamia bengalensis, O. & M.; *Otozamites contiguus*, Feist. } cf. *Otozamites Feistmanteli*, Zign.
Ptilophyllum acutifolium, Morr.; *P. tenerrimum*, Feist.; *P. cutchense*, Morr.; *Otozamites Hislopi*, Old.; *Otozamites distans*, Feist.; *O. gracilis*?; *O. angustatus*, Feist. } cf. *Williamsonia pecten* (Phill.).
Otozamites Bunburyanus = ? *Otozamites Bunburyanus*, Zign.
"Inflorescence of Cycad"; *Williamsonia* cf. *gigas* } cf. *Williamsonia pecten* and *W. gigas.*
Pecopteris indica, O. & M.[1]; *Asplenites macrocarpus* (O. & M.) } cf. *Cladophlebis denticulata* (Brongn.).
Pecopteris lobata, O. & M.; cf. (pars) *Coniopteris arguta* (L. & H.).
Sphenopteris Bunburyanus, O. & M.; cf. *Coniopteris hymenophylloides* (Brongn.).
Alethopteris lobifolia (Phill.) = ? *Cladophlebis lobifolia.*
Pachypteris brevipinnata, Feist.; *Dichopteris ellorensis*, Feist. } cf. *Pachypteris lanceolata*, Brongn.
Araucarites (?) *gracilis*, O. & M.; cf. *Lycopodites falcatus*, L. & H.
Pterophyllum Footeanum, Feist.
Podozamites lanceolatus (L. & H.) = ? *P. lanceolatus.*
Araucarites cutchensis, Feist.; *A. macropterus*, Feist.; *A. kachensis*, Feist. } cf. *Araucarites Phillipsi*, Carr.
Echinostrobus (*Thuytes*) *expansus* (Sternb.); *Brachyphyllum mamillare*, Brongn. } = ? *Brachyphyllum mamillare*, Brongn.
Taxites planus, Feist. = ? *Taxites zamioides* (Leck., ex Bean MS.).
Pachypteris (*Cryptomerites*) *divaricatus* (Bunb.) = *Cryptomerites divaricatus*, Bunb.

AUSTRALIA.

A valuable summary and critical review of the "Fossil Flora of Australia," by Dr. Feistmantel, was published in 1890 by the Department of Mines, New South Wales.[2] This work, which was based on a memoir previously published in the *Palæontographica* (1878–79), contains a comprehensive historical sketch of palæo-botanical literature relating to Australia, and a revised list of fossil plants from various geological horizons.

[1] Identified by Schenk (83), p. 253, as *Asplenium whitbiense.*
[2] Feistmantel (90).

In the following list a few species are enumerated for comparison with British Lower Oolite forms.[1]

Alethopteris australis, Morr. (Victoria, New South Wales, Queensland, and Tasmania); cf. *Cladophlebis denticulata* (Brongn.).
Equisetum rotiferum, Ten.-Woods; cf. *Equisetites columnaris*, Brongn. (smaller form).
Sphenopteris hastata, McCoy } cf. *Coniopteris hymenophylloides* (Brongn.).
S. germana, McCoy }
Sagenopteris rhoifolia, Presl; cf. *S. Phillipsi* (Brongn.).
Podozamites lanceolatus = ? *P. lanceolatus* (L. & H.).
Ptilophyllum oligoneurum, Ten.-Woods; cf. *Williamsonia pecten* (Phill.).
Otozamites Mandelslohi, Kurr.
Jeanpaulia bidens, Ten.-Woods; cf. *Baiera gracilis*, Bunb.
Phlebopteris alethopteroides, Eth.;[2] cf. *Laccopteris polypodioides* (Brongn.).

Since the publication of Feistmantel's work several species of Queensland plants have been recorded by Jack & Etheridge[3] in their *Geology of Queensland and New Guinea.* More recently specimens have been collected by the staff of the Geological Survey, and some of these are described by Shirley[4] in a paper contained in Bulletin No. 7 of the Queensland Geological Survey. Some of the species of *Ginkgo* and *Baiera* instituted by this author are founded on imperfect specimens hardly worthy of being raised to the rank of type-specimens. Among the leaves referred to these two genera there are some examples which bear a fairly close resemblance to *Baiera gracilis*, Bunb., e.g. *Ginkgo bidens* (Ten.-Woods) and *Baiera ipsviciensis*, Shir. A fragment named *Dictyophyllum Bremerense* may be compared with *D. rugosum*, L. & H., and a leaf figured as *Sagenopteris rhoifolia* recalls *S. Phillipsi* (Brongn.). The specimens described as *Beania geminata* afford little or no evidence of generic identity with Carruthers' genus. Some of the fossils figured by these authors are referred to in the descriptive part of the Catalogue.

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[1] For figures, vide Feistmantel (90), McCoy (47) (74), Tenison-Woods (83).
[2] Etheridge (88).
[3] Jack & Etheridge (92).
[4] Shirley (98).

DESCRIPTION OF SPECIMENS.

In the descriptive part of this Catalogue the species are grouped, as far as possible, in accordance with their natural affinities. Some of the genera are discussed at length, but in the majority of cases reference must be made to the two volumes on the Wealden Flora [1] for an account of the history and application of generic names, as also for definitions of Families and Classes. Several of the specimens are from the collection of William Bean, and these usually bear a label with his determination. Bean's names are often quoted in the description of the specimens as occasionally throwing light on the current use in his day of various specific names; but, on the other hand, it is necessary to exercise considerable caution in attaching importance to the determinations of this enthusiastic collector. The localities are, in many cases, too vague to serve as guides to the exact horizon from which the plants were obtained; we frequently find nothing more than "near Scarborough," "near Whitby," "Scarborough," etc., indicating that, as a rule, the necessity of giving accurate information as to the position of the beds had not been realized.

In several instances the difficulty of determination has been considerable, owing to the constantly recurring question as to the advisability of uniting a series of specimens under one specific name or of emphasizing the existence of slight differences by the use of distinct names. It frequently happens that the examination of the material in a single collection leads to the view that certain forms are specifically distinct; but the abundance of specimens in several museums often supplies transitional forms which render

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[1] Seward (94 [1]) (95).

specific separation too artificial. In cases where we have a large number of forms constituting a series, and the extreme types exhibit marked distinctive features, it has been found convenient to use a specific term in a comprehensive sense, and to append a second name as indicative of a 'form' or variety. The species *Sagenopteris Phillipsi* (Brongn.), as used in this sense, includes leaves or leaflets differing considerably from one another in size and shape; but from the analogy of recent plants, and from the occurrence of more or less connecting links between the extreme types, it seems preferable to include all under one term, and to refer to the more distinct forms by varietal names, which in some cases may have been previously used as specific designations. The small form of *Sagenopteris* named by Lindley & Hutton *S. cuneata* may be spoken of as *S. Phillipsi*, var. *cuneata*, while a few examples of unusually large leaves are referred to as *S. Phillipsi*, var. *major*.

My tendency has been to diminish the number of specific names in cases where the data afford insufficient evidence of important differences. It would reduce specific distinctions to an absurdity to designate by a special name the various forms of cycadean or fern leaves which may be grouped around a well-marked type. At best the material is insufficient for accurate diagnosis and determination; and while drawing attention to such forms as afford valuable evidence in the recognition of geological horizons, our chief aim should be to deal with the fossil specimens on the same principles as are applied to recent plants, and to interpret the botanical records in a manner best calculated to render them useful as indices of plant development and distribution.

In a letter to Lyell in 1860, Darwin wrote: "How far to lump and split species is, indeed, a hopeless problem. It must in the end, I think, be determined by mere convenience."[1]

In the description of each species a definition is given after the list of synonyms, and where possible the *locale* of the type-specimen has been mentioned. Comparisons of the fossil types with recent plants are, for the sake of uniformity, usually discussed at the end of the remarks on the synonymy or history of each species.

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[1] I am indebted to my friend Mr. Francis Darwin for permission to quote this passage from an unpublished letter.

The majority of the British Museum specimens are included in the following collections, while some were presented by Dr. Murray, Mr. J. Leckenby, Mr. J. Williamson, Mr. S. P. Pratt, and others:—

Bean Collection.
Beckles Collection.
Bowerbank Collection.
Egerton Collection.
Mantell Collection.
Morris Collection.

The principal localities are Gristhorpe Bay, Scarborough (often used in a wide sense and in some cases including localities nearer Gristhorpe Bay than Scarborough), Cloughton Wyke, Haiburn Wyke, Whitby, and Saltwick. (Vide Text-fig. 1, p. 17.)

LIST OF SPECIES DESCRIBED IN THE PRESENT VOLUME.

Group BRYOPHYTA.

Marchantites erectus (Leck., ex Bean MS.).

Group PTERIDOPHYTA.

Equisetites columnaris, Brongn.
Equisetites Beani (Bunb.).
Lycopodites falcatus, L. & H.
Cladophlebis denticulata (Brongn.).
Cladophlebis haiburnensis (L. and H.).
Cladophlebis lobifolia (Phill.).
Coniopteris arguta (L. & H.).
Coniopteris hymenophylloides (Brongn.).
Coniopteris quinqueloba (Phill.).
Dictyophyllum rugosum, L. & H.
Klukia exilis (Phill.).
Laccopteris polypodioides (Brongn.).
Laccopteris Woodwardi (Leck.).
Matonidium Goepperti (Ett.).
Pachypteris lanceolata, Brongn.
Ruffordia Goepperti (Dunk.).
Sagenopteris Phillipsi (Brongn.).
Sphenopteris Murrayana (Brongn.).
Sphenopteris princeps, Presl.
Sphenopteris Williamsoni, Brongn.
Tæniopteris major, L. & H.
Tæniopteris vittata, Brongn.
Todites Williamsoni (Brongn.).

GYMNOSPERMÆ.

Anomozamites Nilssoni (Phill.).
Araucarites Phillipsi, Carr.
Baiera gracilis, Bunb.
Baiera Lindleyana (Schimp.).
Baiera Phillipsi, Nath.
Beania gracilis, Carr.
Brachyphyllum mamillare, Brongn.
Cheirolepis setosus (Phill.).
Cryptomerites divaricatus, Bunb.

Ctenis falcata, L. & H.
•*Czekanowskia Murrayana* (L. and H.).
Dioonites, sp.
Ginkgo digitata (Brongn.).
Ginkgo whitbiensis, Nath.
Nageiopsis anglica, sp. nov.
Nilssonia compta (Phill.).
Nilssonia mediana (Leck., ex Bean MS.).
Nilssonia tenuinervis, Nath.
Otozamites acuminatus (L. & H.).
Otozamites Beani (L. & H.).
Otozamites Bunburyanus, Zign.
Otozamites Feistmanteli, Zign.
Otozamites graphicus (Leck., ex Bean MS.).
Otozamites obtusus (L. & H.), var. *ooliticus*.
Otozamites parallelus (Phill.).
Pagiophyllum Williamsoni (Brongn.).
Podozamites lanceolatus (L. & H.).
Ptilozamites Leckenbyi (Leck., ex Bean MS.).
Taxites zamioides (Leck.).
Williamsonia gigas (L. & H.).
Williamsonia pecten (Phill.).

Group THALLOPHYTA.

Class ALGÆ.

The few specimens described as Algæ from the Inferior Oolite rocks of Yorkshire are either too imperfect to determine, or in all probability may be more correctly regarded as impressions of thalloid Liverworts. Lindley & Hutton[1] described a fossil from Gristhorpe under the name *Fucoides arcuatus*, and the same species is figured in the third edition of Phillips' *Geology of the Yorkshire Coast*[2]; there is little doubt, however, that the type-specimen of Lindley & Hutton is an imperfect example of Leckenby's *Fucoides erectus*,[3] a species now placed in the genus *Marchantites*. A still more imperfect fossil from Gristhorpe, named by Phillips *Fucoides diffusus*,[4] may also be doubtfully referred to Leckenby's species.

[Ripple-marks simulating a Plant.

40,565. Pl. XIX. Fig. 6.

The specimen represented in Pl. XIX. Fig. 6 was labelled by Bean "*Lepidodendron*? from the Upper Shale of Scarborough," and in the Museum Register the same piece of shale is described as a fern stem. On one side of the rock there is a series of irregularly parallel ridges; and on the other face, as shown in Fig. 6, two sets of ridges intersect, dividing the surface into a number of depressed areas, which present a slight resemblance to a partially decorticated Lepidodendroid stem. The ridges are no doubt ripple-marks produced on the surface of an argillaceous sand; the specimen is of some interest as illustrating a possible source of error, and agrees very closely with a photograph of intersecting ripple-marks figured by Williamson[5] in 1885.

Upper Shale: Scarborough. *Bean Coll.*]

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[1] Lindley & Hutton (36), pl. 185.
[2] Phillips (75), p. 195, lign. 1.
[3] Leckenby (64), pl. xi. fig. 3.
[4] Phillips (75), p. 196, lign. 2.
[5] Williamson (85), pl. iii. fig. 14.

Group BRYOPHYTA (MUSCINEÆ).

Class HEPATICÆ.

The vegetative plant-body possesses a different organization on the ventral and dorsal sides; it has the form of a thalloid creeping plant (thalloid Liverworts), or of a delicate stem with thin appendages or leaves without a midrib (foliose Liverworts).

Order MARCHANTIEÆ.

Genus **MARCHANTITES**, Brongniart.

[Tableau vég. foss. p. 12, 1849.]

Vegetative body of laminar form, with apparently dichotomous branches, agreeing in habit with the recent thalloid Hepaticæ, as represented by such a genus as *Marchantia*.

Marchantites erectus (Leck., ex Bean MS.).

[Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76, 1864.]

(Pl. XIX. Fig. 2; Text-fig. 2.)

1837. *Fucoides arcuatus*, Lindley & Hutton, Foss. Flor. vol. iii. pl. 185.
1838. *Sphærococcites arcuatus*, Sternberg, Flor. Vorwelt, vii. p. 104.
1850. *Sphærococcites arcuatus*, Unger, Gen. spec. plant. foss. p. 26.
1864. *Fucoides arcuatus*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1864. *Fucoides erectus*, ibid. p. 81, pl. xi. figs. 3*a*, *b*.
1869. *Haliseris erecta*, Schimper, Pal. Vég. vol. i. p. 185.
1875. *Fucoides arcuatus*, Phillips, Geol. Yorks. p. 195, Lign. 1.
? *Fucoides diffusus*, ibid. p. 106, Lign. 2.
Fucoides erectus, ibid. p. 196, Lign. 3.
1898. *Marchantites erectus*, Seward, Fossil Plants, vol. i. p. 233, fig. 49.

Type-specimen. Woodwardian Museum, Cambridge (Leckenby Collection, No. 1). Text-fig. 2.

Thalloid body, divided into spreading, dichotomously branched segments, obtusely pointed apically. The slightly wrinkled surface

shows a distinct and comparatively broad darker median band, with lighter-coloured and thinner margins.

The specific name *erectus* proposed by Leckenby in 1864 is adopted in preference to the older term *arcuatus*, because the specimen to which Lindley & Hutton applied the latter name was much more imperfect than Leckenby's type, and it is not certain, although highly probable, that the two are specifically identical. Leckenby's type-specimen presents a striking resemblance to some recent members of the Marchantieæ, and, as



FIG. 2.—*Marchantites erectus* (Leck., ex Bean MS.). Woodwardian Museum, Cambridge (Leck. Coll., No. 1). Nat. size.

Nathorst also suggested, it would seem to be more fitly referred to the Liverworts than to the Algæ. Leckenby, in defining the species, speaks of the occurrence of "fructification in one or more rows of ovate vesicles immersed in the frond,"[1] but an examination of the type-specimen does not reveal any characters suggestive of organs of fructification. The best examples of this plant are those in the Leckenby Collection; in the York Museum there are a few specimens of *M. erectus* labelled *Sphærococcites arcuatus*.

The present species of *Marchantites* bears a close resemblance to *M. Zeilleri*, Sew.,[2] from the Wealden rocks of Sussex; the two may be identical, but the habit of the older form appears to be more spreading and open than in the Wealden species. A small and imperfect fragment has been described by MM. Fliche & Bleicher[3] from the Lower Oolite rocks of Nancy, under the name of *Marchantites oolithicus*, but the material on

[1] Leckenby (64), p. 81.
[2] Seward (94), p. 18, pl. i. fig. 3.
[3] Fliche & Bleicher (82), p. 67, fig. 1.

which the determination is based is too fragmentary to admit of accurate identification.

A more recently described Jurassic Liverwort, *Paleohepatica Rostafinskii*,[1] from the neighbourhood of Cracow, differs from the English species in the broader divisions of the thallus and in its generally larger form.

Pl. XIX. Fig. 2.

V. 3652. A repeatedly forked specimen, with the habit of a dichotomously branched thallose Liverwort, similar to *Marchantia* and other genera. The impression on the sandstone is not very clearly preserved, but there is a distinct indication of a thicker median portion or broad midrib in each branch of the thallus, and a thinner lateral margin, which appears as a light-brown stain on the surface of the rock. Gristhorpe Bay.

Presented by Dr. Murray.

V. 2526. This specimen is labelled in Bean's writing *Fucoides arcuatus*. The lobes of the thallus have a breadth of 3 mm., the midrib being 1 mm. wide. The specimen figured by Lindley and Hutton as *Fucoides arcuatus* has precisely the same habit of branching, but the drawing suggests a stiffer and less delicate plant. In all probability, however, *F. arcuatus* is merely an imperfect example of *Marchantites erectus*.

39,328. Examples with narrower thalloid branches. On the same piece of shale there is an unusually good specimen of *Tæniopteris major*, L. & H.; also fragments of *Nilssonia compta* (Phill.), *Tæniopteris vittata*, Brongn., etc. Upper Shale: Gristhorpe.

Bean Coll.

39,329. Several fragments with narrow branches; labelled by Bean *Fucoides erectus*. The present form of the impressions is probably, to a large extent, due to the partial destruction of the delicate lateral portions of the thallus. Upper Shale: Scarborough.

Bean Coll.

40,571. An imperfect specimen, labelled *Sphærococcites arcuatus* and *Fucoides erectus*. Gristhorpe Bay. *Bean Coll.*

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[1] Raciborski (94), p. 10, pl. vii. figs. 1–3.

Group PTERIDOPHYTA

(VASCULAR CRYPTOGAMS).

Class EQUISETALES.

Perennial plants with underground branched rhizomes, from which are given off roots and erect branched or, unbranched aerial shoots. The shoots are characterized by the small verticillate sheathing leaves borne on the slightly swollen nodal regions; the nodes are separated by longer or shorter internodes. The sporangia occur on specially modified sporophylls or sporangiophores, aggregated to form a definite strobilus or spore-bearing cone.

The Equisetales include the single recent genus *Equisetum* and the fossil genera *Equisetites*, *Phyllotheca*, *Schizoneura*, *Calamites*, and *Archæocalamites*; the genus *Equisetites* is the only one represented in the Yorkshire Oolite flora.

Family EQUISETACEÆ.

An accurate diagnosis of the family Equisetaceæ as including the recent Horsetails and species of *Equisetites* is practically impossible, as our knowledge of the fossils is far from complete. The striking similarity of the fossil stems from Triassic, Jurassic, and more recent formations to the widely distributed Equisetums, justifies the inclusion of *Equisetites* in the Equisetaceæ as a type agreeing in habit, and presumably in structural features, with the recent genus; but our information rests solely on external characters, and we know little or nothing as to the anatomy of the fossil Horsetails, nor have we any evidence as to whether the sporangia contained spores of one kind only or were heterosporous.

Genus EQUISETITES, Sternberg.

[Flor. Vorwelt, v.–vi. p. 43, 1833.]

1. Equisetites columnaris, Brongn.
2. Equisetites Beani (Bunb.).

A generic name applied to such fossil stems as closely resemble the recent genus *Equisetum*.

The various species of *Equisetites* are founded on stems, leaves, and strobili, which occur as casts or impressions, and nothing is known with certainty as to the anatomical characteristics of the fossil forms. The large size of some of the Triassic and Jurassic stems and the fine longitudinal striation occasionally seen on the surface of the casts, render it probable that some at least of the fossil Horsetails grew in thickness by means of the activity of a cambium, as we know to have been the case with the Palæozoic Calamitean plants.

It is an unsatisfactory task to attempt to define the distinguishing characters of species of *Equisetites*, which are usually represented by fragments of rhizomes or aerial shoots. The leaf-sheaths are often imperfectly preserved, and afford uncertain evidence as to specific features; the differences in the diameter of the stem fragments and in the length of the internodes are often such as might easily occur in the same plant.

1. Equisetites columnaris, Brongniart.

[Brongniart, Prodrome, p. 37, 1828.]

(Pl. XIX. Figs. 1, 3, 4, 5; Text-figs. 3, 4.)

1828. *Equisetum columnare*, Brongniart, Prodrome, p. 37.
 E. columnare, Brongniart, Hist. vég. foss. p. 115, pl. xiii.
1829. *Equisetum columnare*, Phillips, Geol. Yorks. p. 153.
 E. laterale, ibid. p. 153, pl. x. fig. 13.
 Oncylogonatum carbonarium, König, in Murchison, Trans. Geol. Soc. [2], vol. ii. p. 300, pl. xxxii.
1833. *Equisetites columnaris*, Sternberg, Flor. Vorwelt, v.–vi. p. 45.
1836. *Equisetum laterale*, Lindley & Hutton, Foss. Flor. vol. iii. pl. 186.
1848. *Equisetites lateralis*, Bronn, Ind. Pal. p. 464.
1849. *Equisetites lateralis*, Brongniart, Tableau, p. 105.

1850. *Equisetites columnaris*, Unger, Gen. spec. plant. foss. p. 56.
E. lateralis, ibid. p. 59.
1851. *Asterophyllites? lateralis*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 189.
1854. *Equisetites lateralis*, Morris, Brit. Foss. p. 8.
1856. *Calamites lateralis*, Zigno, Flor. foss. Oolit. vol. i. p. 46, pl. iii. fig. 3.
Equisetites columnaris, ibid. p. 65.
E. Veronensis, ibid. p. 64, pl. vi.
1864. *Equisetites columnaris*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
E. lateralis, ibid. p. 77.
1869. *Equisetum columnare*, Schimper, Trait. pal. vég. vol. i. p. 266.
Schizoneura? lateralis, ibid. p. 284.
1873. *Equisetum columnare*, Saporta, Pal. Franç. vol. i. p. 254, pl. xxx. fig. 5.
E. Veronense, ibid. pl. xxx. fig. 6.
Cf. *Equisetum Duvalii*, ibid. p. 248, pl. xxx. figs. 1–4.
1875. *Equisetites columnaris*, Phillips, Geol. Yorks. p. 197, Lign. 4 and 5.
E. lateralis, ibid. p. 197, pl. x. fig. 3.
1877. Cf. *Phyllotheca sibirica*, Heer, Flor. foss. Arct. vol. iv. (2[1]), pl. iv. p. 43.
1878. Cf. *P. sibirica*, ibid. vol. v. (2), p. 4, pl. i. figs. 9–15.
1882. Cf. *P. sibirica*, ibid. vol. vi. (2,), p. 9, pl. ii. figs. 5 and 6.
1892. *Equisetum columnare*, Fox-Strangways, Tab. foss. p. 127.
Phyllotheca lateralis, ibid. p. 128.
1894. ? *Equisetum blandum*, Raciborski, Flor. Kopal. p. 233, pl. xxvii. figs. 17–27.

Type-specimen. Paris Museum. The specimens from Whitby on which Brongniart's diagnosis was founded were sent to him by the Philosophical Society of York.

Stem reaching a diameter of 5–6 cm., with internodes 13–14 cm. long. The nodal region slightly swollen, at least in the larger stems or branches, bearing leaf-sheaths closely adpressed to the stem with 70–80 linear acuminate teeth. In the smaller branches the leaf-sheaths consist of a smaller number of segments, and occasionally occur as isolated sheaths with radiating linear teeth apart from the branches or lying on the surface of an internode. In the thicker specimens the free distal ends of the teeth have usually been broken off, the sheaths having a truncated margin. The leaf-segments are separated from one another by a fairly deep V-shaped groove, which widens towards the edge of the leaf-sheath, where the teeth become free. The median portion of each

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[1] The figure placed after the number of the volume indicates the position of the paper quoted in the particular volume of the Flor. foss. Arct.

leaf-segment is flat or slightly depressed, and the edges in well-preserved specimens bear small protuberances, which may be indications of siliceous deposits in the epidermis.

The stem or larger aerial branches bore occasional branches at the nodes, about five at each branching node; the more slender specimens sometimes possess still more delicate branches (e.g. Text-fig. 3).

Nodal diaphragms occur frequently on the lower part of the internodes of the smaller branches, or as isolated discs; the diaphragms consist of a central circular area of tissue, from which radiate narrow bands separated by slightly broader spaces.

Brongniart defined the species in 1828 as follows:—"E. caule erecto, simplici, lævi, cylindrico, diametro 2–3 poll. æquali, articulis versus basim approximatis, superne distantibus; vaginis erectis, cauli arcte applicatis, multidentatis, dentibus brevibus, sed in acumine filiformi caduco productis." [1]

In the work of Young & Bird (1822)[2] a figure is given of a fairly large *Equisetites* branch, and additional drawings of the same species occur in the second edition[3] published in 1828. These authors refer to *Equisetites* as a reed-like plant abundant in the strata exposed in the cliffs opposite High Whitby; they compare the fossils with *Equisetum*, and regard the vertical position of the casts as a proof of their occurrence *in situ*; they suggest, however, that both stems and matrix may have been transported into their present position. It is interesting to notice that Young & Bird speak of the occurrence of lateral branches, a fact overlooked by later writers. The occurrence of branch-scars protruding through the lower portion of the leaf-sheaths of several specimens fully bears out the conclusion of these authors (vide Pl. XIX. Fig. 1).

The casts of *Equisetites columnaris* have long been familiar fossils in the Lower Estuarine beds in the cliffs near Whitby and elsewhere; they often occur in a vertical position in the sandstone,[4] or as flattened carbonaceous impressions on the associated bands of shale. Many writers have expressed the opinion that these Equisetaceous plants contributed largely to the formation

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[1] Brongniart (28[2]), p. 115.
[2] Young & Bird (22), pl. iii. fig. 3.
[3] Ibid. (28), pl. iii. figs. 4–6.
[4] Seward (98), p. 72, fig. 11.

of the thin coal-seams of the Estuarine series; the occurrence of an argillaceous bed crowded with small roots immediately below the coal has suggested a comparison with the underclays of the Coal-measures.

König's species *Oncylogonatum carbonarium*,[1] from the Brora Coalfield of Sutherland, is no doubt identical with *Equisetites columnaris* of the Yorkshire rocks; the coal-seams of the Brora district are considered by König to have been formed, in part at least, from the remains of the reed-like plants to which he applied the above name.[2]

In 1829 Phillips[3] published a figure of a slender fossil stem from Saltwick under the name *Equisetum laterale*, characterized by the occurrence of small circular areas of a wheel-like pattern on the internodal region. The same form of stem was also figured and described by Lindley & Hutton[4] in 1836; by these authors the circular discs are compared with the phragma of a Calamite. They remark that similar discs were said to occur as isolated objects on the surface of the shale (on the authority of "Mr. Williamson, jun."—the late Professor Williamson). In 1851 Bunbury[5] discussed another example of Phillips' species, in which narrow spreading leaves were given off from the node as in *Asterophyllites*. The fossil represented in Text-fig. 3 (No. 40,561) is probably the one which Bunbury had before him, and it is certainly the specimen figured by Zigno as *Calamites lateralis*. The long 'spreading leaves' of these authors are no doubt slender branches, the true Equisetaceous leaf-sheath being faintly shown as a series of small pointed teeth just above the nodes. Heer, misled no doubt by the descriptions of Bunbury and Zigno,[6] proposed to transfer Phillips' species to the genus *Phyllotheca*, and Schimper[7] substituted the generic name *Schizoneura*. The circular discs on

[1] König, in Murchison (29).

[2] Zigno (59), p. 113. Zigno considered the Brora fossil specifically distinct from *E. columnaris*, and proposed to adopt the name *E. Koenigii* in place of König's designation.

[3] Phillips (29), pl. x. fig. 13.

[4] Lindley & Hutton (36), pl. 186.

[5] Bunbury (51), p. 189.

[6] Zigno (56), p. 46.

[7] Schimper (69), p. 286.

the internodes of this form have long proved a difficulty, several authors having regarded them as branch-scars occurring some distance above the nodal region. Lindley compared them with the nodal septa of *Calamites*, and Schimper afterwards regarded them as displaced nodal diaphragms. This is, I believe, the correct explanation of the circular discs.

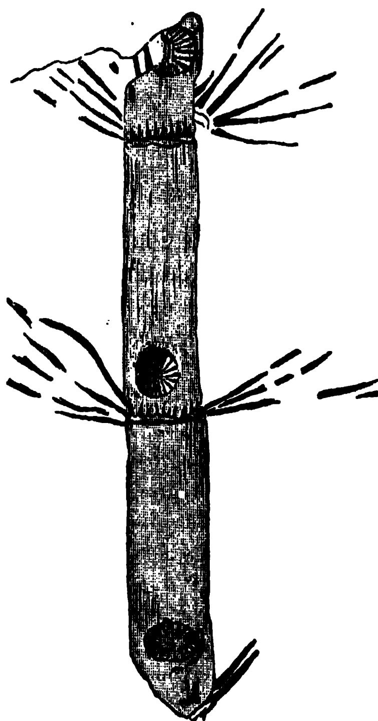


Fig. 3.—*Equisetites columnaris*, Brongn. [No. 40,561.]
(Block lent by the Cambridge University Press.)

The frequent occurrence of isolated nodal diaphragms renders it probable that the tissue of these organs was strengthened by the development of periderm, and possibly by a subsequent sclerification of the cells. It has been shown[1] that the parenchymatous nodal

[1] Williamson & Scott (94), p. 889.

diaphragms of Calamites developed a layer of cork-tissue, and Jeffrey[1] has more recently described the partial sclerification of periderm cells in the diaphragms of recent Horsetails.

The specimen (No. 10,379) represented in Pl. XIX. Fig. 4 affords a good example of an isolated nodal diaphragm, and in Fig. 5 of the same Plate a portion of a similar diaphragm is surrounded by an imperfectly preserved leaf-sheath; the latter specimen, from the Leckenby Collection,[2] demonstrates the nature of the discs, and shows that their usual manner of occurrence a little distance above the node is merely the result of displacement. As the hollow branches were crushed by the weight of overlying sediment the diaphragms, being comparatively resistant, were squeezed from their original position and flattened out on the internode.[3]

It has been the custom to regard the form named by Phillips *Equisetum laterale* as specifically distinct from Brongniart's species; but a comparison of numerous specimens of *Equisetites columnaris* and *E. lateralis* has led me to unite both under Brongniart's designation. Nathorst inclined to this view, as shown by a note written on a specimen of *E. lateralis* in the Leckenby Collection—"*Eq. columnaris* includes *Eq. lateralis.*" The difference in diameter between the smaller examples of *E. lateralis* and the ordinary casts of *E. columnaris* is considerable, but in a large collection it is easy to find intermediate forms; the leaf-sheaths also exhibit no distinguishing features, but agree in the form of the segments and in their minute surface features.

The Italian specimens figured by Zigno[4] as *Equisetites Veronensis* appear to be identical with the common British species, and his species has therefore been included in the above synonymy. The fragments of stems described by Saporta[5] from rocks referred to a Bathonian horizon bears a close resemblance to *Equisetites columnaris*, and may well be specifically identical; but in the absence of more satisfactory evidence than is afforded by Saporta's

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[1] Jeffrey (99), p. 176.
[2] Leckenby Collection, Cambridge, No. 17.
[3] Specimens of nodal diaphragms may be seen in several collections of Jurassic plants; e.g., Oxford, Cambridge, York, Manchester, Scarborough, etc.
[4] Zigno (56), pl. vi.
[5] Saporta (73), p. 248.

figures we may consider the French specimens as probably identical with, or at least closely allied to, the British species.

Heer[1] compares his Siberian species, *Phyllotheca sibirica*, with Phillips' *Equisetum laterale*, but recognizes certain small differences which he considers of specific value. There is, however, so close a correspondence between Heer's figures and some examples of the Siberian plant in the British Museum collection and certain of the Yorkshire specimens, that it would seem very probable the two plants are not specifically distinct.

The specimens figured by Raciborski[2] from the Cracow Jurassic rocks as *Equisetites blandus* present a close agreement with such examples of *E. columnaris* as those shown in Figs. 4 and 5, Pl. XIX., and in Text-fig. 3.

Although no fertile shoots of *E. columnaris* have been recognized, it is reasonable to assume that they were of the same type as the strobili of recent Horsetails, with which the cones of some other Mesozoic species of *Equisetites* closely agree.

It is practically impossible to discriminate accurately between many of the Mesozoic Equisetaceous stems, or to give definite diagnostic characters, but it is at least probable that *Equisetites columnaris* is specifically distinct from the more slender Wealden species *Equisetites Lyelli*, Mant.[3] The latter species never reached the same girth as the older plant, and the more robust habit of the Inferior Oolite and Triassic Horsetails seems to be a well-marked feature of some importance.

Some of the older species of *Equisetites*, e.g. *E. Muensteri*, bear a fairly close resemblance to *E. columnaris*, and, while probably specifically distinct, the former plant must be considered, as Schenk[4] suggests, an analogous species. The specimens figured by Andrae[5] from Steierdorf and by Tenison-Woods[6] from Queensland are too imperfect to admit of satisfactory identification, but the fragments figured by these authors as *Equisetum laterale* and *E. rotiferum*

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[1] Heer (77), vol. iv. (2), p. 43, pl. iv. fig. 2; vide also Heer (78), vol. v. (2), p. 4, pl. i., and (82), ii. p. 9.

[2] Raciborski (94), pl. xxvii. p. 233, figs. 17–27.

[3] Seward (94), pl. i.

[4] Schenk (67), pl. ii. p. 14.

[5] Andrae (55), pl. vi. figs. 1–5.

[6] Tenison-Woods (83), pl. vi. figs. 5 and 6.

respectively recall the slender branches and leaf-sheaths of the English species.

Numerous examples of *Equisetites columnaris* are met with in practically all collections of Inferior Oolite plants. The smaller forms, formerly spoken of as *Equisetites lateralis*, are less common, but good specimens may be seen in the museums of Cambridge, Oxford, Manchester, York, Scarborough, and elsewhere.

The large stems of the recent species, *Equisetum giganteum*, L.,[1] which grows in the marshes of tropical America, may be compared with the still larger plant, which must have formed a prominent feature in the landscape of the low-lying marshy ground bordering the Jurassic sea in the north-west of Europe.

V. 2613*a*. Pl. XIX. Fig. 1.

This small specimen shows two nodes with the short stumps of two alternating whorls of branches. The knobs or branch-scars occur at regular intervals on each branching node, and the members of each whorl are situated midway between those of the next whorl.

In this cast the pointed tips of the leaf-segments have not been preserved, but the form of the sheaths is clearly indicated.

40,681. Pl. XIX. Fig. 3. [Also in Seward (98), p. 265, fig. 58B.]

The large cast, of which the figure represents a portion of one node, measures 49 cm. in length, and affords a good example of the large type of branch with long internodes. The organic substance of the stem has been replaced by a thin film of carbonaceous material encircling the sandstone cast; the bulk of the specimen being no doubt the cast of a large hollow pith. The breadth of the branch is 5·5 cm., and the internodes have a length of 13–14 cm. The leaf-sheaths consist of 70–80 teeth, usually truncate at the margin of the sheath, but in the portion represented in Fig. 3 the acuminate distal ends of the teeth are faintly indicated. The leaf-sheath projected slightly from the surface of the branch, the intervening space being filled with

[1] Hooker (61), pl. lxxiv.

sand, which separates the carbonaceous surface of the sheath from the coaly film on the surface of the main cast.

Scarborough. *Purchased.*

40,561. Text-fig. 3. [Also in Zigno (56), pl. iii. fig. 3, and Seward (98), p. 275, fig. 63.]

There are fragments of several imperfect specimens lying on the shale; the best example, which is shown in the figure, measures 11·2 cm. long and 1·2 cm. in breadth, the internodes having a length of 4·5 cm. Portions of leaf-sheaths with short teeth are faintly indicated at the nodes, and distinct impressions of diaphragms occur above the nodal lines. The long slender appendages, of a light-brown colour, which were formerly described as leaves, are no doubt delicate branches comparable to the finer branches of some of our recent Horsetails. No trace of nodes can be made out on the surface of the branches, but the preservation is far from perfect. A somewhat similar specimen from the Yorkshire coast, with traces of branches, may be seen in the Leeds Museum.

10,379. Pl. XIX. Fig. 4.

An isolated nodal diaphragm, showing a central flat area and slightly convex radiating bands of carbonized tissue separated from one another by spaces. These diaphragms are usually about 1 cm. in diameter, and have the form of a shallow saucer. Part of a similar diaphragm is seen in Fig. 4, lying immediately above the lower leaf-sheath.

The example represented in Fig. 4 (from the York Museum) shows the leaf-sheaths and linear acuminate segments very clearly; it is interesting also as being larger than many of the specimens of the *Equisetites lateralis* type, and serves to connect the wider *E. columnaris* with the narrow branches usually identified as *E. lateralis*.

The diaphragm of the specimen represented in Pl. XIX. Fig. 5 is surrounded by a portion of a leaf-sheath, and affords good evidence in support of the nature of the isolated circular discs, which were considered originally to be the scars of branches.

V. 89. Two pieces of stems on which the surface features of the leaf-sheaths are clearly preserved; on the flat or slightly

concave median portion of each leaf-segment, the outlines of the epidermal cells may be readily detected, and the slightly raised edges bear numerous small irregular tubercles, which may be due to the presence of siliceous deposits in the epidermal cells. On some of the nodes five branch-scars are shown; these alternate in position with the scars on the next node. This form of stem may be compared with the type of Calamitean cast known as *Calamites* (*Eucalamites*) *cruciatus*, Sternb., from the Coal-measures.[1]

Egerton Coll.

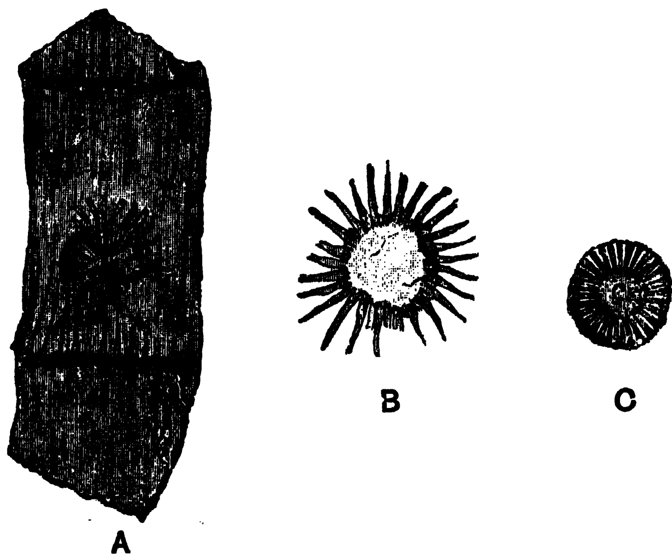


Fig. 4.—*Equisetites columnaris*, Brongn.[2]

A. Part of a stem showing leaf-sheaths, and an imperfect diaphragm flattened on the internode.
B. A single leaf-sheath.
C. A nodal diaphragm.

From specimens in the York Museum. (Block lent by the Cambridge University Press.)

V. 2613. The smaller of the two specimens bearing this number affords a good example of a cast of the typical *Equisetites columnaris*

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[1] Seward (98), p. 377, fig. 102.
[2] Ibid. p. 278, fig. 64.

type, having a smaller diameter than the majority of the cylindrical casts, and each leaf-sheath consists of about forty segments with clearly defined surface characters; this specimen may be compared with Text-fig. 4, which represents a broad form with the characters of *E. lateralis*.

Yorkshire. *Beckles Coll.*

V. 3648. Four casts in a vertical position in a finely laminated sandy shale. *Purchased.*

52,568. A flattened branch showing portions of several leaf-sheaths and many diaphragms scattered about the surface of the shale. The surface of the internodes is well preserved, and presents a finely tuberculated appearance when examined under a pocket lens.

Oolitic Shale, Scarborough. *Bowerbank Coll.*

10,328. Portions of two flattened leaf-sheaths with the long pointed teeth spread out on the surface of the rock: the space enclosed by the basal portion of the leaf-sheath was no doubt occupied originally by a nodal diaphragm, as in the specimen represented in Pl. XIX. Fig. 5.

Cloughton. *Mantell Coll.*

Other specimens:—**V. 2613*b*** (a single node with branch-knobs), **V. 2613*c*, V. 3292** (a block of micaceous sandstone penetrated by root-like fossils which may belong to *Equisetites*), **V. 3649, 13,507, 39,130, 40,468** (part of a flattened leaf-sheath showing good surface features), **40,469, 40,574** (vertical casts in sandstone), **40,575, 52,583.**

2. Equisetites Beani (Bunb.).

[Quart. Journ. Geol. Soc. vol. vii. p. 189, 1851.]

(Text-figs. 5 and 6.)

1851. *Calamites Beani*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 189.
1854. *Calamites Beanii*, Morris, Brit. Foss. p. 3.
1856. *Calamites Beani*, Zigno, Flor. foss. Oolit. vol. i. p. 45, pl. iii. fig. 1.
1869. ? *Equisetum columnare*, Schimper, Trait. pal. vég. vol. i. p. 267.

1880. *Schizoneura* cf. *S. hoerensis*, Nathorst, Berättelse, p. 54.
1883. *Calamites Beanii*, Williamson, R. Instit. p. 4.
1886. *Calamites Beanii*, Gardner, Geol. Mag. vol. iii. [3], p. 201, pl. ix. fig. 3.
1898. *Equisetites Beani*, Seward, Foss. Plants, vol. i. p. 270, figs. 60–62.

Type-specimen. Manchester Museum (No. 88). Stems reaching a circumference of 30 and 40 mm., bearing at the well-defined nodes leaf-sheaths consisting of numerous long and narrow segments.

The scanty material of this species is insufficient to enable us to give a satisfactory diagnosis. *Equisetites Beani* is retained

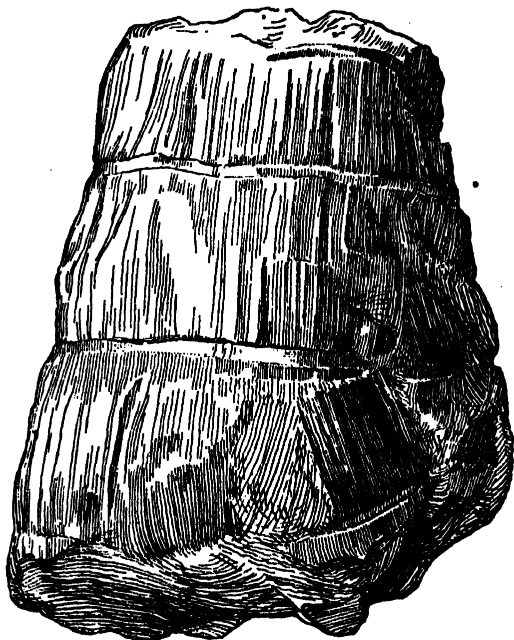


Fig. 5.—*Equisetites Beani* (Bunb.). ⅔ nat. size. [From a specimen in the Manchester Museum; after Starkie Gardner (86), pl. ix. fig. 2.]

as a distinct species chiefly on the ground of the greater diameter of the stem than in *E. columnaris*; in other respects the two species appear to be very similar, and it is not improbable that the stout casts included under the present species may be unusually large examples of the preceding type.

In 1851 Bunbury proposed the name *Calamites Beani* for some sandstone casts of stems from the Inferior Oolite of Yorkshire,

which had been previously named by Bean, in unpublished notes, *Calamites giganteus*. Bunbury's species is referred to by Schimper as being possibly founded on the pith-cast of *Equisetites columnaris*. In 1886 Starkie Gardner published a figure of a specimen which was identified by Williamson as an example of *Calamites Beani*, and compared by the latter author with recent arborescent Gramineæ. Text-fig. 5 is taken from the block used by Gardner in his paper on Mesozoic Angiosperms, in which the specimen is quoted as possibly a Monocotyledonous stem. The cast shows two conspicuous nodal regions, but no trace of leaf-sheaths, and affords no definite evidence of its Equisetaceous nature. Casts like that figured by Gardner occur in the Whitby, York, and Scarborough Museums, and in some cases reach a length of over 40 cm.; they have the form of cylindrical or more or less compressed stems, divided by transverse nodal constrictions into fairly long internodal regions, and occasionally the casts of the several internodes occur as separate pieces, fitting together by clean-cut faces. The larger specimen represented in Text-fig. 6 shows not only nodal regions, but distinct indications of leaf-sheaths which reveal the Equisetaceous character of the casts. Some of the pith-casts of these stems exhibit a fine longitudinal striation on the surface, which suggests the presence of a woody cylinder enclosing the wide pith; it is probable that these large stems grew in thickness by the development of secondary vascular tissue, but we have as yet no precise information as to their anatomy. In the York Museum there are some large circular discs 10 cm. in diameter, enclosed in the matrix of a rock containing a cast of *Equisetites Beani*, which undoubtedly represent the nodal diaphragms of this species.

V. 2725. Text-fig. 6.[1]

This large cast measures 27 cm. in length, and at the second node from the bottom has a breadth of 12 cm. There are seven nodes shown on the stem: the two lowest nodes exhibit distinct impressions of numerous narrow segments of leaf-sheaths, the impressions having the form of tapering narrow ridges representing the grooves between the segments, as seen in surface-view. It is possible that this form of stem may belong

[1] Figured also in Seward (98), p. 271, fig. 61.



Fig. 6.—*Equisetites Beani* (Bunb.). No. V. 2725. $\frac{2}{3}$ nat. size.
(Block lent by the Cambridge University Press.)

to *Equisetites columnaris*, but until further evidence of their connection is forthcoming Bunbury's specific name may be conveniently retained.

On the same piece of rock there are some good examples of the pinnate fronds of *Williamsonia gigas* (L. & H.). *Beckles Coll.*

V. 2725*a*. A fairly common type of cast of this species, in which the nodal regions are marked by distinct constrictions, but without any indication of leaf-sheaths; 33 cm. in length, 15 cm. broad. The fine longitudinal striations in such casts as **V. 2725*a*,** of which there are several examples in the Museums of York, Whitby, and Scarborough, suggest the impression of a cylinder of wood: it has already been pointed out that these larger stems probably possessed the power of secondary thickening.

Beckles Coll.

V. 3929, 39,093 [vide *Williamsonia gigas* (L. & H.)], **40,577.** Similar flattened casts, with nodal constrictions and surface striation as in **V. 2725*a*.**

Class LYCOPODIALES.

Perennial plants of terrestrial, epiphytic, or aquatic habit, usually herbaceous, but more or less shrubby in a few tropical species. Stems for the most part long and slender, dichotomously or monopodially branched; in some forms the stems are short, unbranched, and tuberous. The sporangia are large and exannulate, occurring singly either in the axil of a more or less modified leaf or on the lower part of the upper surface of a leaf.

The living genera included in this class are the isosporous *Lycopodium*, *Phylloglossum*, *Psilotum*, and *Tmesipteris*, also the heterosporous *Selaginella* and *Isoetes*. *Isoetes*, *Selaginella*, and *Lycopodium* are represented by British species, but the other genera have a restricted tropical distribution. The extinct types *Lepidodendron*, *Sigillaria*, and other Palæozoic plants belonging to the Lycopodinæ played an important part in the vegetation of the Carboniferous and Permian periods; they differed from the modern genera in their arborescent habit and in their power of secondary growth in thickness.

Genus **LYCOPODITES**, Brongniart.

[Prodrome, p. 83, 1828.]

Herbaceous or small arborescent plants, agreeing in habit with recent species of *Lycopodium* and *Selaginella*, with branched stems bearing small leaves, either all of the same form or dimorphic, disposed spirally or in rows. Sporangia in the axil or on the upper face of a leaf, or borne on leaves forming a terminal strobilus.[1]

The generic name *Lycopodites* was proposed by Brongniart in 1828 for plants with pinnate branches bearing leaves disposed spirally or in two opposite rows, which on falling did not leave a well-marked or definite leaf-scar. The only Inferior Oolite species (*Lycopodites Williamsoni*) included by Brongniart in his genus is now recognized as a Conifer, most of the species being of Palæozoic age. While some of the specimens placed in *Lycopodites* are in all probability small twigs of *Lepidodendron*, there are a few species which must be retained in Brongniart's genus as differing in certain respects from *Lepidodendron*.

It is usually the case that the specimens described as species of *Lycopodites* have the form of delicate twigs bearing small crowded leaves, but with one or two exceptions there are no indications of the sporophylls, nor is there any evidence as to anatomical characters. The meagre nature of the material makes it impossible to decide in some instances whether *Selaginella* or *Lycopodium* is the most nearly allied genus, and it is safer, therefore, to use Brongniart's generic name in a comprehensive sense as including fossils, which may belong either to the heterosporous Selaginellaceæ or to the homosporous Lycopodiaceæ.

Lycopodites falcatus, Lindley & Hutton.

[Fossil Flora, vol. i. pl. lxi. 1831.]

1831. *Lycopodites falcatus*, Lindley & Hutton, Foss. Flor. vol. i. pl. lxi.
1838. *Muscites falcatus*, Sternberg, Flor. Vorwelt, fasc. vii. p. 38.
1848. *Lycopodites falcatus*, Bronn, Ind. Pal. p. 681.
1849. *Lycopodites falcatus*, Brongniart, Tableau, p. 105.

[1] Cf. Kidston (85), p. 561.

1850. *Lycopodites falcatus*, Unger, Gen. spec. plant. foss. p. 274.
1854. *Lycopodites falcatus*, Morris, Brit. Foss. p. 12.
1856. *Lycopodites falcatus*, Zigno, Flor. foss. Oolit. vol. i. p. 213.
1864. *Lycopodites falcatus*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
1870. *Lycopodium falcatum*, Schimper, Trait. pal. vég. vol. ii. p. 9.
1875. *Lycopodites falcatus*, Phillips, Geol. Yorks. p. 198, lign. 6.
1892. *Lycopodites falcatus*, Fox-Strangways, Tab. Foss. p. 127.

Type-specimen. British Museum, No. **39,314**.

Stem slender, branched in an apparently dichotomous manner, bearing leaves disposed in two rows, and fairly closely arranged, but not contiguous. Leaves thin, entire, broadly falcate, with an acute apex pointing upwards or slightly inclined towards the axis of the branch. Sporophylls unknown.

Lindley & Hutton[1] speak of the plant, which they describe as *Lycopodites falcatus*, as no doubt identical with a specimen figured by Young & Bird,[2] bearing "small round crowded leaves"; but it is not improbable that the drawing given by the latter authors represents a piece of the conifer *Brachyphyllum mamillare*, Brongn.

There is little doubt that *Lycopodites falcatus* should be regarded as a Lycopodinous plant more nearly allied to the genus *Selaginella* than to *Lycopodium*. At the end of the diagnosis of the species given by Phillips,[3] it is stated that he detected "marks of stipulæ" on one of the specimens; these probably represent imperfectly preserved leaves on the upper surface of the stem, differing in their smaller size from the two-ranked leaves, which are distichously disposed. In the type-specimen of Lindley & Hutton (**39,314**) there are in places faint suggestions of smaller leaves, but the preservation is not sufficiently good to render this point certain. The probability is that this species, as Schenk[4] suggests, agrees more closely with the recent genus *Selaginella* than with *Lycopodium*. Solms-Laubach, in speaking of fossil Lycopods, goes so far as to say that "all Lycopodites with distichous leaves may be reckoned without hesitation among heterophyllous forms,"[5] that is, among plants of the type of *Selaginella*. The

[1] Lindley & Hutton (33), pl. lxi.
[2] Young & Bird (22), pl. ii. fig. 7.
[3] Phillips (75), p. 198.
[4] Schenk (88), p. 57.
[5] Solms-Laubach (91), p. 187.

habit of the plant, as well as the arrangement and thin texture of the leaves, and the probable presence of two kinds of leaves, all point to a comparison with recent species of *Selaginella*. Nathorst,[1] on the other hand, has referred to *Lycopodites falcatus* as a representative of the *Lycopodium* type of plant.

Such examples of Lycopodiaceous plants as have been described from foreign Mesozoic localities do not offer any close resemblance to the English species. A species figured by Heer[2] from the Jurassic rocks of Siberia as *Lycopodites tenerrimus* is characterized by narrower leaves, and agrees closely with *Taxodium gracile*,[3] described by the same author. A few specimens figured by Oldham & Morris[4] from the Jurassic rocks of the Rajmahal Hills as *Araucarites* (?) *gracilis*, and afterwards placed in the genus *Cheirolepis* by Feistmantel, may be compared with *Lycopodites*. Feistmantel[5] calls attention to the similarity of the Indian and British fossils, but suggests that both should probably be placed in the Coniferæ rather than in the genus *Lycopodites*. There can be little, if any, doubt as to the Lycopodiaceous nature of *Lycopodites falcatus*, with which the Indian species appears to be closely allied.

The York Museum contains an unusually good example of *Lycopodites falcatus*. Fragments are met with also in the Scarborough, Cambridge, and other collections of Inferior Oolite plants.

39,314. Figured by Lindley & Hutton (33), pl. lxi.

The drawing in the *Fossil Flora* gives a fairly accurate idea both of the habit of the plant and of the form of the leaves. The slender axis is repeatedly forked, and bears apparently two rows of alternately disposed leaves. The leaves, which are in the form of carbonaceous films on a sandy shale, are not preserved sufficiently well to enable one to describe them in detail; they are broadly falcate in form, about 4 mm. in length, with an acute apex directed upwards and slightly inwards. At the tip of

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[1] Nathorst (80), p. 54.
[2] Heer (78), ii. pl. i. fig. 7; and (77), ii. pl. xv. figs. 2–8.
[3] Ibid. (78), iii. pl. viii. fig. 32, etc.
[4] Oldham & Morris (63), pls. xxxiii. and xxxv.
[5] Feistmantel (77[1]), p. 140.

one of the branches there appear to be slight indications of the presence of smaller leaves in addition to the larger ones, suggesting a comparison with *Selaginella*.

Cloughton. *Bean Coll.*

V. 3675. A good specimen, showing the manner of branching and spreading habit of growth. Lower Sandstone, Cloughton.

Class FILICALES.

Stem comparatively small in proportion to the size of the leaves. The members of this class are usually isosporous, but in a few forms heterosporous; sporangia borne on leaves which are either identical with the foliage leaves or more or less modified. Roots developed from the stem in acropetal succession, or borne on the leaf-stalks. The stem may be either polystelic or monostelic.

Sub-Class Filices.

Order LEPTOSPORANGIATÆ.

The Filices or true Ferns are isosporous. The spores on germination produce a green independently growing prothallus, bearing the sexual organs. Leaves relatively large, in nearly all cases with circinate vernation, bearing scaly ramenta or filamentous hairs; the sporangia are usually in groups or sori, either naked or enclosed by an indusium, borne on leaves which may be identical with, or more or less distinct from, the vegetative leaves. With a few exceptions the sporangia possess a well-marked annulus; each sporangium is formed from a single epidermal cell. Stem horizontal and creeping, oblique or vertical, bearing scattered fronds or terminating in a crown of leaves.[1]

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[1] Vide Seward (94), p. 35, for a general "Introduction to the Filices."

A. *Genera assigned to existing families.*

Family MATONINEÆ.

Sori borne on the under surface of ordinary fronds, composed of a few comparatively large sporangia, with tetrahedral spores, sessile on a central columnar receptacle, which in the recent genus *Matonia* spreads out into an umbrella-like indusium, with the recurved margin tucked in below the ring of sporangia. Sporangia characterized by an obliquely vertical incomplete annulus.

The recent Malayan fern *Matonia pectinata*, R. Br., first described by Robert Brown[1] in Wallich's *Plantæ Asiaticæ rariores* has long been recognized as a species which shares certain characters with the Cyatheaceæ and other families, but differs in some of its features from other members of the Filices. Moore[2] referred this species to a special tribe, Matonineæ, and in recent years Baker, Christ, and others have treated the genus *Matonia* as the type of a distinct family, exhibiting points of contact with both the Cyatheaceæ and Gleicheniaceæ. In 1888[3] a second species, *Matonia sarmentosa*, Baker, was discovered by Mr. Charles Hose at Niah, Sarawak, in Borneo; this fern agrees in the structure of the sori with the older species, but is strikingly unlike it in the form of the fronds. It is of interest to note that the anatomical structure[4] of *Matonia pectinata* entirely confirms the conclusions as to the isolated position of this species among existing ferns, which were based entirely on external characters. Comparisons have often been made between *Matonia pectinata* and various Mesozoic species; these rest not merely on a similarity or identity of habit, but on the more trustworthy resemblance of the sori and sporangia. Solms-Laubach[5] cites the genera *Laccopteris*, *Selenocarpus*, *Andriania*, *Clathropteris*, and *Dictyophyllum* as leptosporangiate ferns which agree in certain

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1 Brown, in Wallich (30), vol. i. p. 16.
2 Moore (57), p. 106.
3 Baker (88), p. 256.
4 Seward (99).
5 Solms-Laubach (91), p. 154.

respects both with the Gleicheniaceæ and Cyatheaceæ; *Microdictyon*, *Gutbiera*, and *Carolopteris* may be added to this list as closely allied genera. In his memoir on the Jurassic plants from the neighbourhood of Cracow, Raciborski[1] includes the two fossil genera *Laccopteris* and *Microdictyon* in the family Matonineæ; the latter genus, instituted by Saporta in 1873,[2] I have been led to consider identical with Presl's *Laccopteris*.

Genus MATONIDIUM, Schenk.

[Palæontographica, vol. xix. p. 219, 1871.]

This genus, founded on specimens of sterile and fertile fronds from the Wealden of North Germany, is thus defined by Schenk:—

"Folia sterilia et fertilia conformia flabellato-pinnata, segmenta pinnatifida. Nervi primarii excurrentes, secundarii angulo subrecto egredientes dichotomi, ramuli simplices. Sori biseriales oblongi indusiati. Sporangia receptaculo in ramulo affixa. Annulus obliquus."

It has been the custom to adopt Schenk's genus for such fossil fronds as agree in habit and in the form of the sori with the recent species *Matonia pectinata*, but it is advisable not to attach too great prominence to the habit of the fronds as a guide to family or generic affinity. The habit of *Matonia sarmentosa* is entirely distinct from that of the other species of the genus, and it is probable that older species may have existed which possessed sori and sporangia of the *Matonia* type, but differed from *Matonia pectinata* in the form of their leaves. Since the publication of the British Museum Catalogue of Wealden ferns, in which *Matonidium* is dealt with, an interesting Cretaceous species, *Matonidium Wiesneri*, has been described by Krasser from Cenomanian rocks in Moravia, a type which exhibits a striking resemblance to *Matonia pectinata*; the Moravian plant approaches the recent species even more closely than the allied Wealden and Jurassic fern, *Matonidium Goepperti*. Potonié[3] has suggested the

[1] Raciborski (94), p. 42.
[2] Saporta (73), p. 313.
[3] Potonié (99), p. 359.

advisability of regarding *Matonidium Wiesneri* as a variety of *Matonia pectinata* rather than as a distinct species.

Matonidium Goepperti (Ettingshausen).

[Abh. k.-k. geol. Reichs. vol. i. Abth. 3, No. 2, p. 16, pl. v, 1852.]

(Pl. XI.; Text-fig. 7.)

1843. *Cycadites Althausii*, Dunker, Progr. p. 7.
1846. *Pecopteris Althausii*, Dunker, Wealdenbildung, p. 5, pl. ii. fig. 2.
P. polydactyla, Dunker, loc. cit. p. 5, pl. vii. fig. 4.
P. Conybeari, Dunker, loc. cit. p. 7, pl. ix. figs. 8 and 8*a*.
Alethopteris elegans, Dunker, loc. cit. p. 8, pl. vii. fig. 7.
1849. *Pecopteris polydactyla*, Brongniart, Tableau, p. 107.
P. Conybeari, Brongniart, loc. cit. p. 107.
P. Althausii, Brongniart, loc. cit.
P. elegans, Brongniart, loc. cit.
1850. *Pecopteris polydactyla*, Unger, Gen. spec. plant. foss. p. 177.
P. Conybeari, Unger, loc. cit. p. 177.
P. Althausii, Unger, loc. cit. p. 176.
Alethopteris elegans, Unger, loc. cit. p. 147.
1852. *Alethopteris Goepperti*, Ettingshausen, Abh. k.-k. geol. Reichs. vol. i. Abth. 3, No. 2, p. 16, pl. v.
1854. *Alethopteris elegans*, Morris, Brit. Foss. p. 2.
1856. *Laccopteris Phillipsii*, Zigno, Flor. foss. Oolit. vol. i. p. 195.
1864. *Pecopteris polydactyla*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 80, pl. xi. figs. 1*a* and 1*b*.
1869. *Laccopteris Goepperti*, Schimper, Trait. pal. vég. vol. i. p. 582; Atlas, pl. xxx. figs. 5–8.
L. Phillipsi, ibid. p. 582.
1870. *Pecopteris Althausii*, Trautschold, Nouv. Mém. Soc. nat. Moscou, vol. xiii. p. 28, pl. xix. fig. 3.
1871. *Matonidium Goepperti*, Schenk, Palæontographica, vol. xix. p. 219, pl. xxvii. figs. 5 and 5*a*; pl. xxviii. figs. 1 and 2; pl. xxx. fig. 3.
1874. *Matonidium Goepperti*, Schimper, loc. cit. vol. iii. p. 507.
1875. *Matonidium Goepperti*, Schenk, Palæontographica, vol. xxiii. p. 160, pl. xxvii. fig. 9.
Pecopteris polydactyla, Phillips, Geol. Yorks. p. 207.
1878. *Alethopteris elegans*, Dupont, Bull. Ac. Roy. Belg. vol. xlvi. [2], p. 396.
Pecopteris Conybeari, Dupont, loc. cit. p. 396.
1881. *Matonidium Goepperti*, Heer, Secc. Trab. Geol. Portugal, p. 16, pl. xv. figs. 1–6.
1888. *Matonidium Goepperti*, Schulze, Flor. subhercyn. Kreid. p. 11.
1891. *Laccopteris polydactyla*, Saporta, Pal. Franç. vol. iv. p. 384.
1892. *Pecopteris polydactyla*, Fox-Strangways, Tab. Foss. p. 133.
1899. *Matonidium Goepperti*, Seward, Phil. Trans. vol. cxci, p. 201.

Type. Large specimens of sterile and fertile segments. In the Berlin Collection.

Fronds of similar habit to those of *Matonia pectinata*, R. Br., fan-shaped or pedate, with pinnate or pinnatifid pinnæ, the ultimate segments linear, slightly falcate, bluntly pointed. Sori numerous on the under side of the ultimate segments, in two rows, one row on each side of the prominent midrib, circular or oval in form, covered by an indusium attached to a short central columnar receptacle, which bore the sporangia arranged in a circle. Sporangia with an oblique annulus.

The specimens of *Matonidium Goepperti* hitherto discovered do not afford any satisfactory evidence as to the exact number of the sporangia, nor do we know in detail the character of the venation. It would appear that the sporangia were more numerous in each sorus than in the recent species, and so far as is known the venation appears to agree with that in *Matonia pectinata.*

Reference may be made to Vol. I of the Wealden Catalogue for remarks on the synonymy of this species. The plant named by Phillips *Pecopteris cæspitosa*, and described by him in his *Geology of Yorkshire*, is included as a synonym of *Matonidium Goepperti* in my former list, but an examination of the type-specimen in the York Museum has convinced me that Phillips' specimen must be referred to the genus *Laccopteris.*

V. 3660. Pl. XI. Fig. 3.

The characteristic disposition of the long narrow pinnæ is clearly shown, but the petiole itself has not been preserved. Portions of nine pinnæ are seen, the longest measuring 16·5 cm. in length and about 1 cm. broad, tapering very gradually towards the distal end. The segments are crowded, narrow, and falcate, with a slightly obtuse apex. The lower surface of the pinnæ is represented in the drawing; in each pinnule the midrib forms a prominent ridge, on either side of which there are indistinct depressions marking the position of the sori. The whole surface of each segment appears to have been covered with crowded sori, as in the specimen shown in Text-fig. 7, A. In some of the segments a small umbo in the centre of the soral depression marks the position of the receptacle.

39,254. Pl. XI. Fig. 1.

A fairly large specimen, a portion of which is shown in Fig. 1 to illustrate the origin of about ten fertile pinnæ from the summit of the petiole. The leaf is preserved with the upper face exposed, the sori appearing as two rows of circular elevations. In some places where the carbonaceous film has been removed there appear to be indications of the individual sporangia, but these are not at all clear. The small basal pinnules are well shown. Labelled by Bean *Pecopteris multicaulis*.

Lower Shale, Scarborough. *Bean Coll.*

52,594 and **52,605.** Pl. XI. Fig. 2.

This fragment shows the short rounded pinnules on the basal portions of the pinnæ, and illustrates the occurrence of sori on even the smallest segments. In *Matonidium Goepperti*, as in *Matonia pectinata*, all the segments of a frond appear to be fertile. The figure represents the sori as circular elevations, with a central depression, projecting from the lower surface of the pinnules.

Haiburn Wyke. *Morris Coll.*

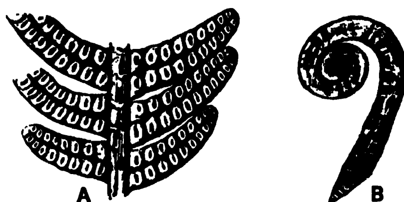


Fig. 7.—*Matonidium Goepperti* (Ett.).

A. Portion of a pinna, showing the sori.
B. The tip of a circinately coiled leaf. (No. 52,596.)

52,596. Text-fig. 7.

Fragments of fertile pinnæ in ironstone, showing both upper and lower surfaces. In the enlarged piece shown in the Text-figure (A) the under surface is uppermost, bearing two rows of crowded elliptical sori. The circinately coiled leaf (Fig. 7, B) preserved in the same piece of rock belongs probably to this species; it agrees exactly with the closely coiled frond of the recent species, *Matonia pectinata*.

Oolitic Shale, Haiburn Wyke. *Morris Coll.*

V. 3661. Several pinnæ of a large spreading frond; the reverse piece of **V. 3660.**

V. 3662. The upper part of a petiole, bearing several palmately disposed pinnæ. Labelled by Leckenby "A new *Pecopteris* from the Lower Sandstone and Shale near Scarborough."

Other specimens:—**V. 3663, 39,297.**

Genus LACCOPTERIS, Presl.

[Presl, in Sternberg, Flor. Vorwelt, fasc. vii. p. 115, 1838.]

1. Laccopteris polypodioides (Brongn.).
2. Laccopteris Woodwardi (Leckenby).

This genus was instituted by Presl in 1838 for some fragments of fern fronds from the Keuper of Strullendorf, the type species being named *Laccopteris elegans.* The generic characters are thus defined:—

"Frons pinnata, nervi primarii excurrentes, nervi secundarii dichotomi ramulis furcatis simplicibusve, mediis in medio dorso soriferis. Sori biseriales, foveæ semiglobosæ immersi, e sporangis compositi."

The same genus is described also by Göppert,[1] Schenk,[2] and other writers. Schenk's account of the species of *Laccopteris* is the fullest, and some excellent figures of the sori, sporangia, and spores accompany his plates of the fronds of this genus. More recently Zeiller[3] has demonstrated the very close resemblance—previously referred to by Schenk—between *Laccopteris* and the recent genus *Matonia.* The published figures of the Rhætic species of *Laccopteris* represent the veins as dichotomizing and not anastomosing; but an examination of specimens in the British Museum and in the Palæontological Institute of Berlin has convinced me that anastomoses are fairly frequent. A specimen of

[1] Göppert (41), Lief. 1 and 2, pls. v. and vi.
[2] Schenk (67), p. 93, pls. xxii.–xxv. Vide also Schenk (88), p. 38, fig. 20.
[3] Zeiller (85).

Laccopteris elegans (Presl) from Bayreuth, in the British Museum Collection (No. 500), shows anastomosing veins in some of the more perfectly preserved pinnules.[1] The *Laccopteris* venation may be compared with that of *Matonia pectinata*, but in the latter fern the anastomes between the lateral veins are rather less numerous than in *Laccopteris*. The close agreement between *Laccopteris* and *Matonia* as regards the form of the frond, the structure of the sori and sporangia, and the venation characters afford sufficient evidence for the inclusion of the genus in the Matonineæ. We may define the genus *Laccopteris* as follows:—

Fronds pedate, in habit like those of *Matonia pectinata*, R. Br., with pinnate or pinnatifid pinnæ; ultimate segments linear in form, with a well-marked midrib giving off numerous secondary veins which branch dichotomously, and are in places connected by short lateral anastomoses. Sori circular, forming a single row on each side of the midrib; the sporangia are usually few in number, from five to fourteen, with an oblique annulus and tetrahedral spores.

1. Laccopteris polypodioides, Brongniart.

[Hist. vég. foss. p. 372, pl. lxxxiii. fig. 1, 1828.]

(Pl. XII. and Pl. XIII, Figs. 1 and 2; Text-figs. 8, 9, 10, 11B, and 11C.)

1828. *Phlebopteris polypodioides*, Brongniart, Hist. vég. foss. p. 372, pl. lxxxiii. fig. 1.
P. propinqua, ibid. p. 373, pl. cxxxii. fig. 1; pl. cxxxiii. fig. 2.
Pecopteris polypodioides, Brongniart, Prodrome, p. 57.
1829. *Pecopteris cæspitosa*, Phillips, Geol. Yorks. p. 148, pl. viii. fig. 10.
P. crenifolia, ibid. p. 148, pl. viii. figs. 11 and 11*a*.
P. ligata, ibid. pl. viii. fig. 14.
1832. *Pecopteris polypodioides*, Lindley & Hutton, Foss. Flor. pl. lx.
1834. *Pecopteris propinqua*, ibid. pl. cxix.
1835. *Phlebopteris contigua*, ibid. pl. cxliv.
1836. *Hemitelites polypodioides*, Göppert, Foss. Farrn. p. 336, pl. xv. figs. 8 and 9.
Polypodites Lindleyi, ibid. p. 342, pl. xxxviii. figs. 5 and 6.
Hemitelites Brownii, ibid. p. 334, pl. xxxviii. fig. 1.
Polypodites crenifolius, ibid. p. 343.

[1] Seward (99), p. 195, fig. 8.

1838. *Steffensia polypodioides*, Sternberg, Flor. Vorwelt, fasc. vii. p. 125.
Phlebopteris polypodioides, ibid. p. 163.
P. contigua, ibid. p. 164.
Steffensia crenifolia, ibid. p. 124.
1848. *Phlebopteris polypodioides*, Bronn, Ind. Pal. p. 959.
Polypodites crenifolius, ibid. p. 1027.
P. Lindleyi, ibid.
Pecopteris cæspitosa, ibid. p. 914.
1849. *Phlebopteris polypodioides*, Brongniart, Tableau, p. 105.
P. contigua, ibid.
Polypodites crenifolia, ibid.
P. Lindleyi, ibid.
1850. *Hemitelites polypodioides*, Unger, Gen. spec. plant. foss. p. 161.
H. Brownii, ibid.
Polypodites crenifolius, ibid. p. 167.
1851. *Pecopteris cæspitosa*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 186.
1854. *Phlebopteris contigua*, Morris, Brit. Foss. p. 17.
P. polypodioides, ibid.
Polypodites crenifolius, ibid. p. 18.
P. Lindleyi, ibid.
Pecopteris cæspitosa, ibid. p. 15.
1855. *Polypodites crenifolius*, Andrae, Foss. Flor. Siebenbürgens, etc., p. 35.
1856. *Polypodites Lindleyi*, Zigno, Flor. foss. Oolit. vol. i. p. 162.
Phlebopteris polypodioides, ibid. p. 172.
P. contigua, ibid. p. 175.
Polypodites crenifolius, ibid. p. 163.
1864. *Phlebopteris contigua*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
P. propinqua, ibid. p. 80.
1869. *Phlebopteris polypodioides*, Schimper, Trait. pal. vég. vol. i. p. 624.
P. contigua, ibid. p. 625.
1875. *Phlebopteris polypodioides*, Phillips, Geol. Yorks. p. 202, lign. 10.
P. Lindleyi, ibid. p. 202.
P. contigua, ibid.
P. crenifolia, ibid. pl. viii. fig. 11.
Pecopteris cæspitosa, ibid. p. 207, pl. viii. fig. 10 and lign. 20.
? *Marzaria Simpsoni*, ibid. p. 204, lign. 13 and 14.
1892. *Phlebopteris contigua*, Fox-Strangways, p. 133.
P. polypodioides, ibid. p. 134.
Pecopteris cæspitosa, ibid. p. 132.
? *Marzaria Simpsoni*, ibid. p. 131.
Cf. *Laccopteris*, n.sp., Barth. Bot. Tids. pl. x. fig. 1.

Type-specimens. Paris Museum. [Type of *Phlebopteris propinqua* and *P. polypodioides*, L. & H., in the Scarborough Museum; type of *P. crenifolia* in the York Museum.]

Fronds of the *Laccopteris* habit; a long petiole subdivided at the summit into several spreading pinnatifid pinnæ with linear ultimate segments passing gradually into shorter or deltoid segments towards

the base of each pinna. Sori borne in two rows, on the under surface of the segments, one row on each side of the midrib; each sorus consists of as many as twelve or fourteen large sporangia (Text-fig. 10), with an oblique annulus and tetrahedral (?) spores. The sori are circular in form, probably without an indusium; but this point is difficult to decide with certainty, the individual sporangia being attached to a central receptacle as in *Matonia*. Each segment is traversed by a well-defined midrib, from which numerous secondary veins are given off at a wide angle; these form a series of elongated areolæ parallel to the midrib, as in the recent genus *Woodwardia*, and from the areolæ or meshes forked and

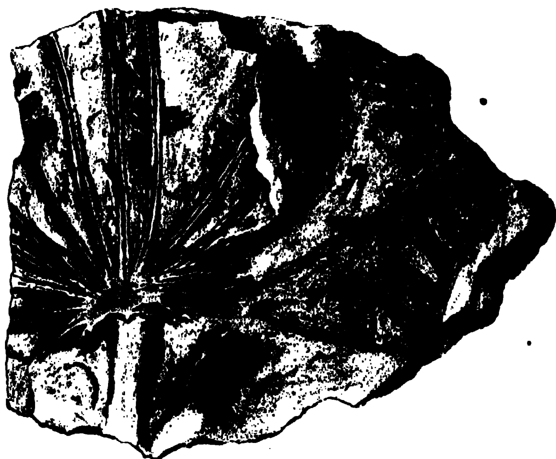


FIG. 8.—*Laccopteris polypodioides*. From a specimen in the York Museum. (¾ nat. size.)

anastomosing branches pass off to the border of the segments; the veins form fairly regularly radiating meshes below each sorus. (Text-fig. 11, and Pl. XIII. Fig. 2.)

Brongniart [1] inclines to the view that the specimens named by Lindley & Hutton *Pecopteris propinqua* are probably not specifically distinct from *P. polypodioides*; an examination of the type-specimen of the former 'species' in the Scarborough

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[1] Brongniart (28²), p. 374.

Museum convinced me that it is identical with Brongniart's type. Nathorst,[1] who regarded *Laccopteris* as a more suitable generic designation than *Phlebopteris*, has expressed the view that *Phlebopteris polypodioides*, *P. crenifolia*,[2] and *P. propinqua* are specifically identical; the same author also states that Phillips' species *Pecopteris ligata*[3] is identical with *Laccopteris polypodioides*.



FIG. 9.—? *Laccopteris polypodioides*. From a specimen in the Whitby Museum. (Nat. size.)

The specimen figured by Phillips (in the York Museum) as *Pecopteris cæspitosa*, and redrawn in Text-fig. 8, is undoubtedly a badly preserved fragment of a leaf of *Laccopteris polypodioides*;[4] the characteristic habit of the frond is clearly shown, and in some of the pinnules there are distinct traces of sori.

The drawing reproduced in Text-figure 9 was made from

[1] Nathorst (80), pp. 60 and 79.

[2] The type-specimen of this species is in the York Museum.

[3] The type-specimen is said by Nathorst to be in the Oxford Museum. Seward (99), p. 201 (footnote).

a specimen in the Whitby Museum (No. 2379) which was figured inaccurately both by Young & Bird and by Phillips, and by the latter referred to Zigno's genus *Marzaria*. The type-specimen of *Marzaria Simpsoni* is in all probability a young frond of *Laccopteris polypodioides*; the linear pinnules of the adult leaf are represented by irregular rounded crenulations on the margin of the pinnæ, and bear a resemblance to the small and partially developed ultimate segments on a young frond of *Matonia pectinata*.

There is a striking similarity between the Inferior Oolite species *L. polypodioides* and the older species *L. affinis*, *L. Muensteri*, and *L. Goepperti* figured by Schenk and other authors.[1] The fern described by Etheridge from the Ipswich Coal-measures, New South Wales, as *Phlebopteris alethopteroides* may be compared with *Laccopteris polypodioides*.[2] It is evident that Brongniart's type is a member of a family which in the Mesozoic period was represented by numerous and closely allied forms with a wide geographical range. At the present day *Matonia pectinata* survives as one of two species which have persisted within narrow geographical limits as tropical representatives of a once vigorous and widely spread family of ferns.

39,251. Pl. XII. Figs. 1 and 1*a*.

This specimen illustrates very clearly the characteristic habit of the frond; five pinnæ are shown converging towards a common petiole. The form of the leaf is precisely similar to that in *Matonia pectinata* and in *Matonidium Goepperti* (Ett.). Each pinna has a broad central axis bearing fairly broad ultimate segments with a midrib and anastomosing secondary veins. One of the lower deltoid segments is slightly enlarged in Fig. 1*a*; this shows the forked and anastomosing secondary veins. The longest pinnule measures 1·2 cm. in length.

Scarborough. *Bean Coll.*

39,252. Pl. XII. Fig. 2.

In this specimen there are portions of five or six pinnæ not far from their common origin from the petiole; these bear

[1] Schenk (67), pls. xiii., xxiii.–xxv.

[2] Etheridge (88), p. 1306, pl. xxxviii. figs. 1 and 2.

crowded, broad linear segments with the venation characters clearly preserved. The lowest segment has a length of 8 mm., and the longest is 2 cm. long. Most of the examples of this species have longer, narrower, and less crowded segments than the two specimens represented in Pl. XII. This specimen is labelled by Bean *Phlebopteris frondosa.*

Upper Shale, Scarborough. *Bean Coll.*

39,225. Pl. XIII. Fig. 2.

Labelled by Bean *Phlebopteris contigua* and *P. polypodioides.* This specimen shows portions of large pinnæ with long linear segments preserved in ironstone and showing well-defined venation (Fig. 2*a*).

Upper Shale, Scarborough. *Bean Coll.*



Fig. 10.—*Laccopteris polypodioides.* A single sorus. [No. V. 2522.]

V. 2522. Text-figs. 10 and 11B.

Part of a fertile pinna in the form of a brown impression, as in **39,252,** but the pinnules are fertile, also longer and farther apart. The sori are circular and arranged on either side of the midrib; each sorus consists of about twelve sporangia with a well-marked oblique annulus. In most of the sori the sporangia have fallen off, leaving a gap in the lamina. Such sporangia as have been preserved are thoroughly carbonized, but the prominent walls of the annulus cells stand out distinctly as black ridges. The drawing in Text-fig. 11B shows the venation clearly and the disposition of the circular sori; the fragment from Stamford, shown in

Fig. 11c, is probably specifically identical with the Yorkshire species. Cf. the figures and sori of *Laccopteris* by Schenk & Zeiller.

Gristhorpe Bay. *Purchased.*

39,275. Pl. XIII. Fig. 1.

Part of a large pinna, with pinnules longer and more tapering than those of **39,252** (Pl. XII. Fig. 2). The segments are always contiguous basally, where they are attached to the axis of the pinna. Sori indistinct.

Upper Shale, Scarborough. *Bean Coll.*

V. 3666. A clearly preserved impression in ironstone of large pinnules which vary in breadth, the fertile segments being narrower than the sterile.

Gristhorpe.

10,333. Imperfect fertile pinnules, in some of which the margin is slightly undulate, but this character is by no means constant, and is in part due to inequalities on the surface of the rock.

Upper Shale, Gristhorpe. *Mantell Coll.*

10,371. Large sterile segments, 4·5 cm. long and 6 mm. broad, showing very distinct venation.

Upper Sandstone, Scarborough. *Mantell Coll.*

39,243. A fairly large example of fertile pinnules, about 4 cm. in length and 4 mm. broad; individual sporangia may be recognized on some of the segments.

Upper Shale, Scarborough. *Bean Coll.*

Other specimens:—**V. 3667, 11,014, 39,246** (a badly preserved specimen labelled by Bean *Pecopteris undans*), **39,247, 39,253, 40,469.**

2. Laccopteris Woodwardi (Leckenby).

[Quart. Journ. Geol. Soc. vol. xx. p. 81, 1864.]

Text-fig. 11A.

1856. *Phlebopteris Woodwardi*, Zigno, Flor. foss. Oolit. vol. i. p. 174.

1864. *Phlebopteris Woodwardi*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 81, pl. viii. fig. 6.

1869. *Phlebopteris Woodwardii*, Schimper, Trait. pal. vég. vol. i. p. 626.

1873. *Microdictyon Woodwardianum*, Saporta, Pal. Franç. vol. i. p. 313, pl. xxxiii.
?*M. rutenicum*, ibid. p. 309, pl. xxxiii. figs. 2–4; pl. xliv.
1875. *Phlebopteris Woodwardii*, Phillips, Geol. Yorks. p. 202.
1892. *Phlebopteris Woodwardi*, Fox-Strangways, Tab. Foss. p. 134.
Cf. *Microdictyon Woodwardianum*, Bartholin, p. 24, pl. x. figs. 2–4.

Type-specimen. Woodwardian Museum, Cambridge (Leckenby Collection, No. 126).

Habit in all probability identical with that of the preceding species. The venation of the ultimate segments similar to that of *Laccopteris polypodioides*, but the veins that spring from the large areolæ next the midrib are more numerous and closer together; the sori are circular and, except in their smaller size, apparently identical with those of Brongniart's species.

Leckenby founded this species on some fragments of pinnules identical with the specimen represented in Text-fig. 11A. It

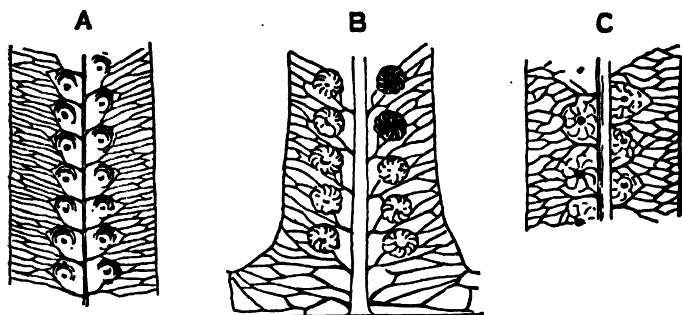


Fig. 11.

A.—Pinnule of *Laccopteris Woodwardi* from the Inferior Oolite of Yorkshire, showing reticulate veins and hemispherical bosses with a small central depression, marking the position of circular sori which were attached to a central receptacle. (No. 217, British Museum.)

B.—Pinnule of *Laccopteris polypodioides*, with sori and soral impressions. Upper Shale, Gristhorpe Bay. (No. 2522, British Museum.)

C.—Pinnule fragment from the Inferior Oolite of Stamford. (No. 52,867, British Museum.)

(Block lent by the Royal Society.)

is probable that Leckenby's type is specifically distinct from *Laccopteris polypodioides*, but the difference between the two ferns appears to be slight; the former is characterized by its smaller

pinnules, the more numerous veins, and the greater number and smaller size of the sori. *Laccopteris Woodwardi* is represented in the English rocks by single detached pinnules, and no examples occur comparable in size and preservation to the fronds of *L. polypodioides* figured in Plates XII. and XIII.

V. 217 (Text-fig. 11A) and **V. 2522*a*.** Fragments of fertile pinnules showing the characteristic small circular sori and the numerous veins given off at a wide angle from the areolæ.

Upper Shale, Gristhorpe Bay. *Purchased.*

40,670. Numerous fragments; the broadest of which has a breadth of 7 mm. *Bean Coll.*

Family OSMUNDACEÆ.

Genus TODITES.

The term *Todites* is employed in preference to the recent generic name *Todea*, which has been used by some authors, on the ground that we are here dealing with a fossil type which it is inadvisable to designate by the name which is applied to recent ferns. The sporangial characters and the form of the frond afford satisfactory evidence not only of Osmundaceous affinities, but lead us to regard the fossils as very closely allied to the recent fern, *Todea barbara*, Moore.

The generic name *Todeopsis* has been employed by Renault[1] for some sporangia from the Culm of d'Esnost which in the form of the annulus recall those of *Todea*. Considering the great difference in age between Renault's specimens and the Lower Oolite fern, and the absence of decisive evidence as to the affinity of the French fossils, it is probably wiser to employ a distinct name for the Jurassic Osmundaceous fern.

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[1] Renault (96), p. 21.

Todites Williamsoni (Brongn.).

[Hist. vég. foss. p. 324, pl. cx. figs. 1, 2, 1828.]

(Pl. XIV. Figs. 2, 5, and 7; Pl. XV. Figs. 1–3; Pl. XXI. Fig. 6; Text-fig. 12.)

1828. *Pecopteris Williamsonis*, Brongniart, Prodrome, p. 57.
P. Williamsonis, Brongniart, Hist. vég. foss. p. 324, pl. cx. figs. 1 and 2.
P. whitbiensis, Brongniart, Prodrome, p. 57.
P. whitbiensis, Brongniart, Hist. vég. foss. p. 321, pl. cix. figs. 2–4.
P. tenuis, ibid. p. 322, pl. cx. figs. 3, 4.
1829. *Pecopteris recentior*, Phillips, Geol. Yorks. p. 148, pl. viii. fig. 15.
? *P. hastata*, ibid. pl. viii. fig. 17.
P. curtata, ibid. p. 148, pl. viii. fig. 12.
1833. *Neuropteris recentior*, Lindley & Hutton, Foss. Flor. vol. i. pl. lxviii.
Pecopteris Williamsonis, ibid. vol. ii. pl. cxxvi.
1835. *Pecopteris dentata*, ibid. vol. iii. pl. clxix.
1836. *Acrostichites Williamsonis*, Göppert, Foss. Farrn. p. 285.
Neuropteris recentior, ibid. p. 205.
Alethopteris dentata, ibid. p. 306.
1838. *Neuropteris recentior*, Sternberg, Flor. Vorwelt, vii. p. 76.
Pecopteris Williamsonis, ibid. p. 151.
P. Huttoniana, ibid. p. 157.
1848. *Alethopteris dentata*, Bronn, Ind. Pal. p. 23.
Acrostichites Williamsoni, ibid. p. 10.
Neuropteris recentior, ibid. p. 811.
1849. *Cladophlebis dentata*, Brongniart, Tableau, p. 105.
C. Williamsonis, ibid.
C. recentior, ibid.
C. tenuis, ibid.
C. whitbiensis, ibid.
1850. *Alethopteris dentata*, Unger, Gen. spec. plant. foss. p. 149.
Acrostichites Williamsonis, ibid. p. 141.
Neuropteris recentior, ibid. p. 85.
1851. *Acrostichites Williamsonis*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 187.
1854. *Pecopteris Huttoniana*, Morris, Cat. Brit. Foss. p. 15.
Acrostichites Williamsonis, ibid. p. 1.
Neuropteris recentior, ibid. p. 13.
1856. *Pecopteris Huttoniana*, Zigno, Flor. foss. Oolit. vol. i. p. 133.
Acrostichites Williamsonis, ibid. p. 149.
Pecopteris recentior, ibid. p. 127.
? *Dichopteris microphylla*, ibid. p. 122, pl. xv. fig. 5.
1864. *Pecopteris dentata*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
Acrostichites Williamsonis, ibid. p. 76.
Neuropteris recentior, ibid.

1868. *Acrostichites Williamsonii*, Eichwald, Leth. Ross. p. 17, pl. ii. fig. 3.
1869. *Pecopteris* (*Acrostichites*) *Williamsoni*, Schimper, Trait. pal. vég. vol. i. p. 528.
Alethopteris recentior, ibid. p. 566.
1874. *Cladophlebis dentata*, ibid. vol. iii. p. 505.
C. recentior, ibid.
1875. *Pecopteris dentata*, Phillips, Geol. Yorks. p. 208, lign. 21.
P. curtata, ibid. p. 209, pl. viii. fig. 12.
P. Williamsonis, ibid. p. 209, lign. 23, pl. x. fig. 7.
P. recentior, ibid. p. 211, pl. viii. fig. 7.
1877. ? *Asplenium whitbiense*, Heer, Flor. foss. Arct. vol. iv. (ii.) p. 39, pl. iii. figs. 1, 2; pl. xx. fig. 4.
? *A. whitbiense tenue*, ibid. p. 39, pl. iii. fig. 3; p. 94, pl. xvi. fig. 8; pl. xx. figs. 1 and 3.
1885. *Todea Williamsonis*, Schenk, Palæont. vol. xxxi. p. 168, pl. iii. fig. 3.
1889. *Cladophlebis virginiensis*, Fontaine, Potomac Flora, p. 70, pl. iii. figs. 3–8; pl. iv. figs. 1 and 4.
C. parva, ibid. p. 73, pl. vi. figs. 1–3.
C. distans, ibid. p. 77, pl. xiii. fig. 4.
Asplenium whitbiense, Yokoyama, Journ. Coll. Sci. Japan, vol. iii. p. 32, pl. iii. fig. 3.
1890. *Pecopteris curtata*, Schimper & Schenk, Handbuch, p. 100.
P. recentior, ibid.
1891. *Todea Williamsonis*, Raciborski: Engler, Bot. Jahrb. xiii. p. 2, pl. i. figs. 7–10.
1892. *Acrostichites tenuis*, Fox-Strangways, Tab. Foss. p. 128.
A. Williamsonis, ibid.
Pecopteris dentata, ibid. p. 132.
1894. *Todea Williamsonis*, Raciborski, Flor. Krak. p. 158, pl. vi. figs. 17–20.
Cladophlebis whitbiensis, ibid. p. 215, pl. xxi. figs. 1, 2, 8–10.
C. solida, ibid. p. 79, pl. xxiv. figs. 10–13.
1896. *Todea Williamsonis*, Hartz, Med. om Grönland, vol. xix. p. 232, pl. xii. figs. 4 and 4*a*.

Type-specimen. Natural History Museum, Paris. [Type-specimen of *Pecopteris dentata*[1] in the Manchester Museum, Owens College.]

Frond bipinnate. The rachis straight and stout, especially in the fertile fronds, often more than 1 cm. in breadth.

Pinnæ long, 20–30 cm., of uniform breadth, linear and gradually tapering to an acuminate apex, alternate and crowded on the rachis, given off at an acute angle (cf. Pl. XV. Fig. 2), but in the lower part of a frond the habit is more open and spreading and the pinnæ are almost at right angles to the rachis.

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[1] Seward (00), pl. i.

Pinnules attached by a broad base, closely set on the axis of the pinna, but the longer fertile segments of the larger pinnæ are farther apart and more open in their arrangement. Slightly falcate, the side towards the rachis is strongly convex, and the outer margin is straight or concave, and bulged outwards towards the base of each segment; the apex of the pinnules is acute; the margin is in some cases, especially in the larger segments, slightly lobed. In the larger pinnæ the pinnules may be between 1·5–2 cm. in length. Towards the distal tapering end of the pinnæ the pinnules are more falcate, and assume a short deltoid form (as in *Pecopteris dentata*, L. & H.), and the acute apex is directed forward. The venation is of the *Cladophlebis* type; each segment being traversed by a midrib from which spring forked secondary veins, and the midrib itself breaks up into dichotomously branched veins towards the tip of the segments.

The fertile pinnules have usually the same form as the sterile, but in the larger segments the breadth is often less in proportion to the length than in the sterile segments, and the margin of the former often shows a tendency towards irregular lobing.

The sporangia are large and circular, and of the Osmundaceous type; they usually cover the whole of the under surface of the fertile segments, as in *Todea*.

The long list of synonyms demonstrates the confusion with regard to the nomenclature of this common and characteristic Jurassic fern. The confusion is considerably increased by the fact that the fern to which Brongniart gave the name *Pecopteris whitbiensis*—a species usually considered to have been very widely distributed during the Jurassic period—is not identical with the plant to which Lindley & Hutton and several other authors applied the same designation. Brongniart's *Pecopteris whitbiensis* I have no doubt is specifically identical with his *Pecopteris Williamsonis*, and with the specimen described under this name by Lindley and Hutton. On the other hand, the *Pecopteris whitbiensis* of Lindley & Hutton and of several other writers is, I believe, specifically identical with *Pecopteris denticulata* of Brongniart; but this question is more fully discussed under the latter species. *Pecopteris tenuis* of Brongniart is included in the above synonymy as identical with *Todites Williamsoni*, as the form of the pinnules and the habit of the frond appear to agree exactly with the characters of that species. Nathorst has expressed similar views

with regard to the identity of these ferns,[1] and Brongniart[2] himself speaks of the "extrême affinité" of the two species. The specimens referred by Phillips and Lindley & Hutton to *Pecopteris recentior* differ from Brongniart's *Pecopteris Williamsonis* in the larger and longer pinnules, but an examination of several large fronds in various collections has convinced me of the identity of the two forms. Specimens of undoubted *Todites Williamsoni* are often met with in English museums bearing the name *Pecopteris recentior*, given to them by Bean and other contemporaries of Phillips and Lindley & Hutton, and there is no doubt that the examples so designated are simply the lower parts of large fronds of *T. Williamsoni*. Phillips' figure of what he names *Pecopteris curtata* represents the characteristic fertile pinnules of *Todites*.

The type-specimens of *Pecopteris dentata*, L. & H., were fortunately discovered in the Williamson Collection in the Manchester Museum;[3] they exhibit the characteristic pinnæ and closely set short and broad segments of *Todites Williamsoni*, agreeing exactly with such specimens as **39,250** (Pl. XIV. Fig. 7), **V. 3654**, and others, and with the figures of *Pecopteris whitbiensis* of Brongniart.

In 1836 Göppert adopted his generic name *Acrostichites* for *Pecopteris Williamsonis*, on account of the manner of occurrence of the sporangia as shown in the figure of Lindley & Hutton. Many authors have retained this genus, but as Schenk and Raciborski have demonstrated, the structure of the sporangia clearly points to the inclusion of the species in the Osmundaceæ; the sporangial characters being such as we are familiar with in *Todea* and *Osmunda*.

The figures given by Zigno of a portion of a fertile bipinnate frond, which he names *Dichopteris microphylla*,[4] bear a striking resemblance to *Todites*, and it is probable that the Italian plant is specifically identical with the present species. There is a close agreement between *Acrostichites Goeppertianus*[5] from the German Rhætic beds and *Todites Williamsoni*, but there are certain small

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[1] Nathorst (80^1), p. 57.

[2] Brongniart (28^2), p. 323. Cf. pl. cx. fig. 4, and pl. cix. figs. 2–4.

[3] Since this was written the type-specimen has been refigured; vide Seward (00), pl. i.

[4] Zigno (56), pl. xv. fig. 5.

[5] Schenk (67), p. 45; pl. v. fig. 5; pl. vii. fig. 2.

differences in the form of the pinnules which render the inclusion of Schenk's species in the list of synonyms inadvisable; the two forms, however, are closely allied.

Amongst the numerous specimens of ferns of the *Cladophlebis* type figured by Heer from the Jurassic and Cretaceous rocks of Siberia and other northern regions, we find several fronds, or rather fragments of fronds, which are probably closely allied to or even identical with *Todites Williamsoni*. He applies the generic name *Asplenium*[1] to many of the leaves without adducing satisfactory evidence of the relationship to the recent genus. The fertile fragment of *Asplenium whitbiense* figured by this author appears to agree in the distribution of the sporangia and in the shape of the segments with the present species, and differs from the specimens in which the sori bear a resemblance to those of *Asplenium*. While feeling confidence in the identity of some of Heer's so-called *Asplenium* species from Siberia with *Todites Williamsoni*, it is practically hopeless to attempt an accurate determination of the species without a careful examination of the fossils themselves.

In Fontaine's *Potomac Flora*, which we now know to include both Wealden and Jurassic species, there are several examples of *Cladophlebis* fronds which may be reasonably identified with *Todites Williamsoni*. Fontaine's zeal for the institution of new species led him to adopt new names for plants which in some cases he admits bear a striking resemblance to known European forms; he has frequently described under distinct specific names portions of fronds which one would reasonably expect to find as parts of one large leaf. *Cladophlebis virginiensis*, Font., is in all probability identical with *Todites*; it agrees very closely with the English specimens with the larger pinnules, but in the absence of fertile pinnæ it is almost impossible to speak with certainty. The examples with smaller pinnules which he names *Cladophlebis parva* agree exactly with the smaller forms of *Todites Williamsoni*, as represented in Pl. XXI. Fig. 6 of this Catalogue; similarly, his *C. distans* is probably identical with the same species. Fontaine refers to the similarity of his *Cladophlebis parva* and *Pecopteris dentata* of Lindley & Hutton, and adds, "one may well hesitate to separate them"; but he considers the venation is not quite

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[1] Heer (77), ii. pl. xxi. fig. 4.

identical. An examination of the type of Lindley & Hutton leads me to recognize the venation characters as being in the closest agreement.

It is to Schenk and Raciborski that we are indebted for the detailed examination of the sporangia of *Todites Williamsoni*: the former author[1] published a figure of a fertile pinnule bearing well-preserved sporangia in his paper on the plants collected by Szechenyi in China, and Raciborski[2] has since confirmed Schenk's conclusions. There are several ferns figured by different authors as *Asplenium whitbyense*, which may be identical with *Todites*, but in many cases it is impossible to speak positively without seeing the specimens.[3] The rich flora of the Jurassic rocks of the Cracow district contains several excellent specimens of *Todites*; some of these are referred to *T. Williamsoni* by Raciborski, while others, which I believe to be specifically identical, are placed under different names. This author uses the specific designation *whitbiensis* in Brongniart's sense, and includes under that name certain fronds which cannot be separated from *Todites Williamsoni*. Raciborski's figures in Engler's *Jahrbuch* and in his *Jurassic Flora of Cracow* should be consulted as the best so far published of the sporangia of *Todites*.

It is, I believe, safe to assert that the recent Australian and South African fern *Todea barbara*, Moore, is the species which agrees most closely with one of the commonest plants in the fern vegetation of the Inferior Oolite period.

The last English specimen of *Todites Williamsoni* that I have seen in which the sporangial characters are clearly shown is in the Leckenby Collection, Cambridge (No. 48). The Museums of York, Scarborough, Manchester, and Whitby contain numerous examples of this common Inferior Oolite species, bearing a variety of names, e.g., *Pecopteris Lindleyana*, *Neuropteris recentior*, *N. undulata*, *N. lobifolia*, *Pecopteris dentata*, *P. whitbiensis*, *P. curtata*, etc. A specimen in the Museum of Lund (No. 568), labelled by Nathorst *Acrostichites*, n.sp., is probably a small example of *Todites Williamsoni*. There is a striking similarity between some of the

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[1] Schenk (85), pl. iii. fig. 3.
[2] Raciborski (94), pl. vi.
[3] E.g. Schenk's figure of a Chinese fern (83), pl. lii. fig. 1.

species of *Acrostichites* figured by Fontaine in the *Older Mesozoic Flora of Virginia*[1] and *Todites Williamsoni*.

39,234. Pl. XV. Fig. 2.

A large specimen 45 cm. in length, bearing crowded linear pinnæ springing from the broad rachis at a wide angle. The longest pinna measures 15·5 cm. in length; the pinnules are broad and short, and closely set on the long pinna axis. This example shows very clearly the characteristic habit of the frond, the long and very gradually tapered pinnæ, and the crowded, short, and broad pinnules, with their inner margins strongly convex and the outer edge straight or slightly concave and bulging outwards towards the broad base. The venation is clearly shown. Cf. this specimen and the examples with larger pinnules, e.g. **14,202.**

Gristhorpe. *Bean Coll.*

13,491. Pl. XV. Figs. 1 and 3.

This specimen, a portion of which is represented in the figure, affords a good example of the common fertile frond of *Todites Williamsoni*. The rachis is 8 mm. broad, and bears pinnæ 1·3 cm. in breadth; the under surface of the pinnules shows the midrib and secondary veins distinctly, and scattered circular pits marking the position of sporangia. (Pl. XV. Fig. 3.) Cf. the longer fertile frond of the same type, **39,271.**

Haiburn Wyke. *Presented by Dr. Murray.*

39,274. Pl. XXI. Fig. 6.

An instructive specimen of a large sterile frond, 19 cm. in length, of the form figured by Lindley & Hutton as *Pecopteris dentata*. The rachis gives off numerous crowded pinnæ, the longest of which is 14 cm. long and 1·3 cm. in breadth; as shown in the figure, the ultimate segments become more falcate and sharply pointed towards the tips of the pinnæ. The margins of the pinnules appear to be entire, but in some of them the margin is slightly irregular; each pinnule is traversed by a midrib, from which are given off forked secondary veins at an acute angle.

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[1] Fontaine (83).

This specimen may be compared with *Cladophlebis parva*, Fontaine, and with the smaller specimens of *C. virginiensis* of the same author.

There is no doubt as to the identity of such a specimen as **39,274** and the type-specimen of *Pecopteris dentata* of Lindley & Hutton.

Scarborough. *Bean Coll.*

V. 3659. Pl. XIV. Fig. 6 (enlarged $\frac{2}{1}$).

Part of a frond of the same form as **39,274** (Pl. XXI. Fig. 6). Some of the pinnules have a slightly dentate or irregular margin, which appears to be an original character, and not entirely the result of decay.

Labelled by Bean *Pecopteris dentata.*

Upper Sandstone and Shale, Scarborough.

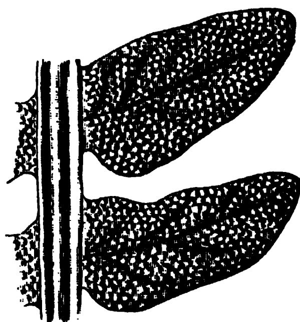


Fig. 12.—*Todites Williamsoni* (Brongn.). (× 3.) [No. 39,233.]

39,233. Text-fig. 12.

A fertile frond with rachis 17 cm. long. The pinnules have a more or less undulated outline, as shown in the enlarged drawing, but the specimen is most probably specifically identical with *Todites Williamsoni.*

39,250. Pl. XIV. Fig. 7.

The apical portion of a frond, showing the linear pinnæ with the short and broad curved pinnules, passing up through serrate segments into the pinnate apex. In the Leckenby Collection, Cambridge (No. 48), there is a more perfect specimen with an

apex identical with that of **39,250** (Fig. 7) and bearing on the lower part of the frond fertile pinnules with well-preserved sporangia. The pinnæ of these specimens are identical with those of the frond figured by Lindley & Hutton as *Pecopteris dentata.*

A piece of *Nilssonia compta* occurs in association with the *Todites* leaf.

Scarborough.

39,226. Pl. XIV. Fig. 5.

This specimen shows portions of large pinnæ almost at right angles to the rachis. The longest pinnules are about 1·3 cm. in length, and of thin texture; there are no definite teeth, but the margin of some of the segments is slightly irregular or wavy. Towards the tip of the pinnæ the segments assume a more falcate form, but in the basal portions they are practically straight.

Labelled by Bean *Neuropteris recentior.* Cf. specimens **134,992, 13,505**, etc.

Oolitic Shale, Gristhorpe Bay. *Bean Coll.*

13,494. Pl. XIV. Fig. 2.

This type of specimen is very difficult to determine; it bears a close resemblance to some forms of *Cladophlebis denticulata* (Brongn.), but the broad bases of the pinnules and the habit of the frond point to *Todites Williamsoni* as the more likely species.

Gristhorpe Bay. *Presented by Dr. Murray.*

V. 2521. An imperfectly preserved fertile frond, labelled by Bean *Pecopteris curtata.* Long pinnæ are attached at a wide angle to the broad rachis; the fertile pinnules have a somewhat ragged outline, and are longer and narrower than the sterile pinnules of such a pinna as that of Fig. 5 (**39,226**). The specimen is evidently from the lower part of a fertile frond, where the pinnules are longer and less crowded on the pinnæ than in the smaller fronds of the type represented in Pl. XV. Fig. 1 (**13,491**).

V. 3654. Part of a large frond, showing in some of the pinnæ a gradual transition from the longer and straighter pinnules to the shorter, falcate, and more acutely pointed segments; a passage from the form originally described as *Pecopteris recentior* to that

named by Lindley *P. dentata.* Labelled by Bean *Neuropteris recentior.* Cf. the fertile pinnules of **39,233** (Text-fig. 12).

Bowerbank Coll.

V. 3655. Rachis 35 cm. long. The pinnules of the *Pecopteris recentior* type. Cf. some of the pinnules of this specimen with those shown in Text-fig. 12 (**39,233**).

Scarborough.

V. 3656. Rachis 29 cm. long; the longest pinna 18 cm. This example is of the form represented in Fig. 2, Pl. XV. (**39,234**), and illustrates the habit of a frond with the long, narrow, and crowded pinnæ bearing short and broad segments.

Oolitic Ironstone, near Scarborough.

V. 3658. Portions of two pinnæ with pinnules showing well-preserved veins. The margin of some of the segments is slightly irregular and suggestive of lobing; length of segments about 1·7 cm.

V. 3668. A fine frond, with large pinnæ and pinnules 1·2 cm. long. Cf. **39,277**, etc.

V. 3664. Part of a fertile frond. The pinnules of the same type as those in **39,233** (Text-fig. 12), and closely resembling the sterile segments of **39,230**.

10,369. Similar to **39,233** (Text-fig. 12). The numerous sporangia are represented by circular pits on the lower surface of the segments.

Gristhorpe Bay. *Mantell Coll.*

134,992. This specimen affords an example of the larger fertile segments with an irregularly lobed margin; some of the pinnules have an entire margin like that of the sterile pinnæ.

Gristhorpe Bay.

13,505. Similar to **134,992.** A piece of a broad sterile pinna occurs in association with the fertile fragment.

14,202. A good specimen preserved in ironstone; the rachis is 1 cm. broad, and the longest pinna reaches a length of 18 cm., with large pinnules similar to those of **V. 3655**, etc.

Near Scarborough.

39,231. Part of a very large frond; rachis 1·4 cm. broad, with long spreading pinnæ 2·5 cm. in breadth; the pinnules are almost at right angles to the pinnæ, and the pinnæ of the lower part of the specimen are also approximately at right angles to the rachis. Labelled by Bean *Pecopteris hastata*, Phill.

Upper Shale, Cloughton Wyke. *Bean Coll.*

39,271. A fertile frond with a rachis 1·2 cm. broad. Short and stumpy pinnules bearing sporangia, as in the specimen shown in Pl. XV. Fig. 1 (**13,491**).

39,277. This form of frond, with large pinnules 1·6 cm. long, bears a distinct resemblance to *Cladophlebis denticulata*, but the pinnæ are more crowded, the frond has a less open habit, and the segments are broader at the base. One pinna has a length of 23 cm.

Gristhorpe. *Bean Coll.*

Other specimens:—**V. 2520, V. 2527, 8250, 13,505, 39,228, 39,262** (labelled by Bean *Pecopteris curtata*), **40,468, 40,469.**

Several examples of this species are included in the collections of York, Scarborough, Whitby, Manchester, and other places.

Family CYATHEACEÆ.

It is not always an easy matter to draw a satisfactory distinction between fossil ferns which exhibit the characters of the Cyatheaceæ, and those which should be compared with some recent species of *Davallia*. While admitting with Nathorst that the genus *Davallia* was probably represented in the Jurassic vegetation by near allies, I have been led to conclude that the Cyatheaceæ played a prominent part in the fern floras of the Mesozoic period.

Genus **CONIOPTERIS**, Brongniart.

[Tableau foss. vég. p. 26, 1849.]

1. Coniopteris hymenophylloides (Brongniart).
2. Coniopteris quinqueloba (Phillips).
3. Coniopteris arguta (Lindley & Hutton).

Brongniart made use of this generic name for such fossil fern fronds as show characters more or less intermediate between *Pecopteris* and *Sphenopteris*, and agree with the recent Dicksonieæ in the form of the sori. Saporta adopted this term and, like Brongniart, he quotes *Tympanophora* of Lindley & Hutton as the type of a fertile pinna of the genus *Coniopteris.* The following definition is given by Saporta of Brongniart's genus:—

"Le genre *Coniopteris* ainsi constitué comprend des espèces à pinnules stériles, plus ou moins rétrécies à la base, lobées, denticulées sur les bords et pourvues d'une nervation pinnée; les fructifications, en forme de clou, de rein ou de coin, plus ou moins élargies au sommet, sont disposées vers l'extrémité des nervures secondaires qu'elles terminent; le limbe contracté a disparu en tout ou en partie, et la pinnule, dans les portions fertiles des frondes, le trouve presque réduite aux seules mesures élargies en clou et servant de support aux sores. Ces organes disposés en forme de réceptacle, de texture évidemment coriace, sont généralement rangés deux par deux de chaque côté de la médiane." [1]

Solms-Laubach,[2] in referring to the Jurassic fern originally named by Brongniart *Pecopteris Murrayana*, and by some other authors included in the recent genus *Thyrsopteris*, advocates the retention of the generic designation *Coniopteris* in preference to a term implying identity with a recent genus. There is little doubt that the Jurassic fern described in this Catalogue as *Coniopteris hymenophylloides* is very closely allied to some recent species of *Dicksonia* as well as to the monotypic genus *Thyrsopteris*; but rather than make use of such terms as *Dicksonites* or *Thyrsopteris*, it is a safer plan to retain the genus *Coniopteris* and definitely include the species among the Cyatheaceæ. Schimper also applies

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[1] Saporta (73), p. 287.
[2] Solms-Laubach (91), p. 157.

Brongniart's genus to some of the species originally placed in his group *Sphenopteris-Dicksonioides*, including the Yorkshire species, *C. Murrayana* and *Tympanophora racemosa*. For reasons stated below, I regard most of the specimens previously identified as *Sphenopteris*, *Pecopteris*, *Thyrsopteris*, or *Coniopteris Murrayana* as identical with *Sphenopteris hymenophylloides*, Brongn., and the latter specific name has therefore been adopted.

1. Coniopteris hymenophylloides (Brongniart).

[Hist. vég. foss. p. 189, pl. lvi. fig. 4, 1828.]

Pl. XVI. Figs. 4–6; Pl. XVII. Figs. 3, 6–8; Pl. XX. Figs. 1 and 2; Pl. XXI. Figs. 1–4.

1828. *Sphenopteris hymenophylloides*, Brongniart, Hist. vég. foss. p. 189, pl. lvi. fig. 4.
S. hymenophylloides, Brongniart, Prodrome, p. 51.
Pecopteris Murrayana, Brongniart, Hist. p. 358, pl. cxxvi. fig. 5.
1829. *Sphenopteris stipata*, Phillips, Geol. Yorks. p. 147, pl. x. fig. 8.
S. muscoides, ibid. p. 153, pl. x. fig. 10.
1835. *Sphenopteris arguta*, Lindley & Hutton, Foss. Flor. pl. clxviii.
Tympanophora simplex, ibid. pl. clxx. A.
T. racemosa, ibid. pl. clxx. B.
1836. *Hymenophyllites Phillipsii*, Göppert, Foss. Farrn. p. 256.
1838. *Sphenopteris hymenophylloides*, Sternberg, Flor. Vorwelt, p. 60.
Polystichites Murrayana, ibid. p. 117.
1848. *Hymenophyllites Phillipsi*, Bronn, Ind. Pal. p. 602.
Tympanophora simplex, ibid. p. 1340.
T. racemosa, ibid.
Sphenopteris muscoides, ibid. p. 1169.
1849. *Sphenopteris hymenophylloides*, Brongniart, Tableau, p. 105.
Coniopteris Murrayana, ibid. (pars).
Tympanophora simplex, ibid.
T. racemosa, ibid.
1850. *Hymenophyllites Phillipsii*, Unger, Gen. spec. plant. foss. p. 129.
Pecopteris Murrayana, ibid. (pars), p. 179.
Tympanophora simplex, ibid. p. 520.
T. racemosa, ibid.
1851. *Sphenopteris nephrocarpa*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 179, pl. xii. figs. 1*a* and 1*b*.
1854. *Tympanophora simplex*, Morris, Brit. Foss. p. 24.
Sphenopteris hymenophylloides, ibid. p. 21.
S. muscoides, ibid.
1856. *Hymenophyllites Phillipsii*, Zigno, Flor. foss. Oolit. vol. i. p. 90.
H. Murrayana, ibid. p. 92.

1863. Cf. *Sphenopteris Bunburyanus*, Oldham & Morris, Pal. Ind. pl. xxxii. p. 54.
Cf. *Pecopteris lobata* (pars), ibid. pl. xxix. p. 52.
1864. *Sphenopteris hymenophylloides*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
S. nephrocarpa, ibid. p. 79.
Pecopteris? Murrayana, ibid. (pars), p. 76.
Tympanophora racemosa, ibid. p. 79.
T. simplex, ibid.
1869. *Sphenopteris* (*Dicksonioides*) *hymenophylloides*, Schimper, Trait. pal. vég. vol. i. p. 395.
S. (*D.*) *nephrocarpa*, ibid. p. 395.
Coniopteris Murrayana, ibid. p. 469.
1873. *Sphenopteris Pellati*, Saporta, Pal. Franç. vol. i. p. 278, pl. xxxi. fig. 1.
? *Coniopteris conferta*, ibid. p. 289, pl. xxxi. fig. 3.
1874. *Coniopteris Murrayana*, Schimper, Trait. pal. vég. vol. iii. p. 471.
1875. *Sphenopteris Murrayana*, Phillips (pars), Geol. Yorks. p. 212, lign. 26.
S. affinis, ibid. p. 213, lign. 30.
S. dissocialis, ibid. p. 214, lign. 32.
S. hymenophylloides, ibid. p. 215, lign. 34.
S. muscoides, ibid. p. 217, pl. x. fig. 10.
Tympanophora simplex, p. 219, lign. 43.
T. racemosa, p. 219, lign. 42.
1876. *Thyrsopteris Murrayana*, Heer, Flor. foss. Arct. vol. iv. (2) p. 30, pl. i. fig. 4; pl. ii. figs. 1–4; pl. viii. fig. 11*b*.
? *Adiantites Schmidtianus*, ibid. pl. ii. fig. 12.
Thyrsopteris Maakiana, ibid. p. 31, pl. i. figs. 1–3, 5, 6.
1878. *Thyrsopteris Murrayana*, ibid. vol. v. (2) p. 1, pl. i. fig. 6.
Dicksonites clavipes, ibid. p. 33, pl. ii. fig. 7.
1880. *Thyrsopteris Maakiana*, Nathorst, Berättelse, p. 38.
Dicksonia nephrocarpa, ibid. p. 56.
1883. ? *Thyrsopteris orientalis*, Schenk, China, pl. lii. fig. 4.
? *Dicksonia coriacea*, ibid. figs. 5, 6.
1889. ? *Dicksonia nephrocarpa*, Yokoyama, Journ. Coll. Sci. Japan, vol. iii. 1889, p. 25, pl. i. fig. 1.
Thyrsopteris Murrayana, ibid. p. 22, pl. xii. fig. 5.
? *Adiantites Heerianus*, ibid. p. 28, pl. xii. fig. 1.
1891. ? *Sphenopteris minutuloba*, Saporta, Pal. Franç. vol. iv. pl. lvi.
1892. *Thyrsopteris Murrayana*, Raciborski, Flor. Krak. p. 130, pl. x. figs. 15 and 16; pl. xii. figs. 17–21.
Dicksonia Heerii, ibid. p. 174, pl. x. figs. 5–14.
*D. Zareczny*i, ibid. (pars), p. 175, pl. xii. figs. 8, 9, 11, and 12.
Thyrsopteris (*Sphenopteris*) *Murrayana*, Fox-Strangways, p. 136.
Sphenopteris affinis, ibid. p. 134.
S. dissocialis, ibid. p. 135.
Dicksonia (*Sphenopteris*) *hymenophylloides*, ibid. p. 130.
D. (*S.*) *nephrocarpa*, ibid.
Sphenopteris muscoides, ibid. p. 135.

• *Type-specimens.* *Sphenopteris hymenophylloides*, Brongn., in the Paris Museum. [*S. arguta*, L. & H., Manchester Museum.[1] *S. nephrocarpa*, Bunb., Leckenby Coll., Cambridge. *S. Murrayana*, with fertile pinnæ of *Tympanophora racemosa*, figured by Leckenby, in the Leckenby Coll., Cambridge. *S. muscoides*, Phill., York Museum.]

Frond tripinnate; pinnæ linear acuminate, attached to the rachis at a wide angle; the pinnules vary considerably in size and shape, in some forms they have a few broad and rounded lobes and in others the lamina is deeply dissected into narrow linear segments. The fertile pinnules bear the sori at the ends of the veins; the lamina is usually much reduced, and in extreme cases the fertile segments agree closely with those of *Thyrsopteris elegans*, Kze., or *Dicksonia Bertervana*, Hook. The sori are partially enclosed in a cup-shaped indusium; the sporangia appear to have an oblique annulus of the Cyatheaceous type. The two lowest pinnules of a pinna are often characterized by their unusual shape, the lower half of each pinnule consisting of long spreading and irregular *Aphlebia*-like lobes (vide Pl. XXI. Figs. 1–4).[2]

Venation and form of the frond of the *Sphenopteris* type.

Brongniart's figure of the type-specimen of *Sphenopteris hymenophylloides* agrees very closely with the example represented in Pl. XX. Fig. 1 of this Catalogue; the only difference being that Brongniart's specimen is a somewhat large form. Phillips' species *S. stipata* is included by the French author as a synonym of *S. hymenophylloides*. The following is the original diagnosis of *S. hymenophylloides* :—

"S. foliis bipinnatis, tenuissimis, pinnis lineari-lanceolatis, rachi alato; pinnulis approximatis, ovatis, pinnatifidis, lobis ovatis tridentalis, inferiori et exteriori (versus apicem pinnarum) majori, pinnatifido; nervulis tenuissimis."

Brongniart compares *S. hymenophylloides* with the filmy ferns *Hymenophyllum* and *Trichomanes*, but with his usual astuteness he expresses the opinion that there is a more perfect analogy with some of the recent Dicksonias, e.g. *D. rubiginosa*, *D. dissecta*, etc.

Phillips' species, *S. stipata*, is represented in the first edition of the *Geology of Yorkshire* by a very poor figure; in the third

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[1] Refigured, Seward (00), p. 6, fig. 1.

[2] Cf. certain Palæozoic ferns some of which Potonié has referred to the genus *Alloiopteris*: Potonié (99), p. 139.

edition it is transferred to *S. hymenophylloides*, and compared with the recent species *Davallia canariensis*, Smith.

In the *Geological Survey of the Yorkshire Coast*, by Young & Bird, some small specimens of Sphenopteroid ferns are illustrated by very inadequate and crude figures, some of which certainly represent Brongniart's *S. hymenophylloides*; the original of fig. 5, pl. ii. of the first edition of this work is undoubtedly a fragment of the present species.[1]

Among the numerous examples of ferns in the Museums of Whitby, Scarborough, Cambridge, York, and elsewhere, which I regard as specifically identical with *Coniopteris hymenophylloides*, there are several labelled by Bean and others *Sphenopteris* or *Pecopteris Murrayana*. This brings us to the question of the possible identity of the plant which Brongniart named *Pecopteris Murrayana* and his species *S. hymenophylloides*. It is probable that under the former designation the French author included more than one species; some of the specimens, e.g. that of fig. 3, pl. cxxvi.,[2] I am of opinion should be referred to *Coniopteris hymenophylloides*, but some of the others may be retained under the name *Sphenopteris Murrayana*. Brongniart's fig. 3 of *S. Murrayana* agrees closely with Fig. 2, Pl. XXI. and with Fig. 6, Pl. XVI. of this Catalogue. A Bornholm fern, *Pecopteris Pingelii*, is considered identical with *Sphenopteris Murrayana*, and this species may probably be added to the synonymy under *C. hymenophylloides*.

There are some other species figured in the *Histoire* which should perhaps be transferred to the latter species; the fragments named by Brongniart *Sphenopteris crenulata* may well be identical with *C. hymenophylloides*, but on this point it is difficult to speak with certainty (cf. Pl. XX. Fig. 1, and Brongniart's pl. lvi. fig. 3). *Sphenopteris denticulata*, Brongn., is another species which may be compared with *C. hymenophylloides*, but so far as it is possible to base an opinion on the figure, it would seem more probable that it is identical with *S. Williamsonis*, Brongn. (cf. Brongniart's figure[3] and Pl. XVII. Fig. 2).

An examination of the type-specimen of *Sphenopteris arguta* of Lindley & Hutton leads me to regard that species as identical with

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[1] Young & Bird (22), loc. cit.

[2] Brongniart (28[2]).

[3] Brongniart (28[2]), pl. lvi. fig. 1.

Coniopteris hymenophylloides.[1] The fragment drawn by Williamson in pl. clxviii. of the *Fossil Flora*[2] is precisely similar to the specimens represented in Pl. XX. Fig. 1 and in Pl. XVI. Fig. 4.

In the third edition of Phillips' *Geology of Yorkshire* there are portions of various Sphenopteroid fronds figured under several specific names, but in many cases the drawings are not accurate enough to render possible the recognition of the type-specimens. Some of the species of *Sphenopteris* instituted in Phillips' work are no doubt identical with *C. hymenophylloides*: of these may be mentioned *S. affinis*, agreeing with Pl. XX. Fig. 2; also *S. socialis* and *S. dissocialis*. It is clear that the fertile pinnæ of the form originally named by Lindley & Hutton *Tympanophora*, and compared by them to an alga, are of the same type as we now find among Cyatheaceous ferns, the sori being partially enclosed by a cup-shaped indusium and consisting of several sporangia with an obliquely vertical annulus. It has been the custom of many authors to consider this *Tympanophora* form of fertile pinna closely allied to, or identical with, Kunze's recent species of the monotypic genus *Thyrsopteris*, now confined to Juan Fernandez. The use of this generic name has, however, been much too widely used by palæobotanical writers. I have elsewhere drawn attention to the obvious misuse of this generic name by Fontaine in his *Potomac Flora*.[3] Other writers have adopted, to a less degree, the same misleading use of this genus. It is true that some of the examples of fertile pinnæ from the Lower Oolitic rocks are practically identical with those of *Thyrsopteris elegans* and are in all probability very near allies of this recent species, but we find precisely similar fertile pinnæ in other genera of recent Cyatheaceæ as in the species *Dicksonia Bertervana*, Hook., represented in Text-fig. 13. In this species the lamina of the fertile segments is considerably reduced, and the indusium consists of a cup with two lips; this two-lipped form of the indusium is not a character easy to recognize in a fossil specimen, nor is it by any means very obvious in dried examples of recent fronds.

There is the question of the identity of various types of fertile pinnæ met with in association with sterile pinnules of

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[1] Seward (00), p. 7.
[2] Lindley & Hutton (35), pl. clxviii.
[3] Seward (94), p. 45.

C. hymenophylloides. Lindley & Hutton instituted two species, *Tympanophora simplex* and *T. racemosa*; Bunbury described another species in which the lamina of the fertile pinnules is less reduced, as in *Sphenopteris nephrocarpa*, and compared this type with recent species of *Dicksonia.* All these can, however, be connected by intermediate forms, and we have insufficient evidence to justify their recognition as distinct species. In the *Tympanophora simplex*

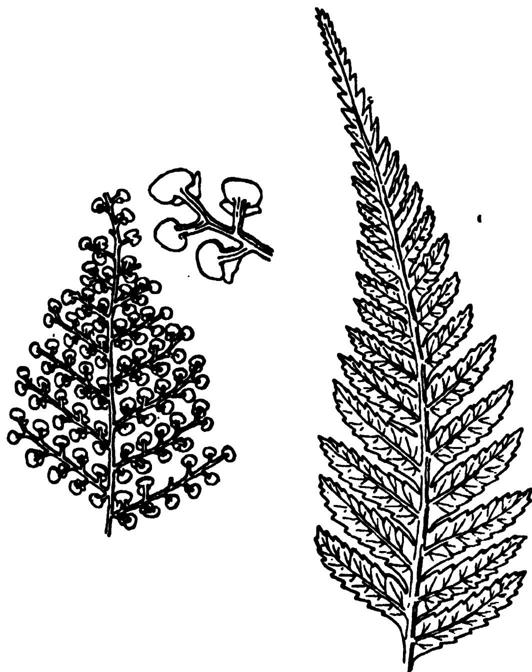


FIG. 13.—*Dicksonia Berteroana*, Hook. (From a specimen in the British Museum Herbarium.)

type the sori are larger and more prominent than in *T. racemosa*, of which a single pinnule bears several sori; this difference is, however, most probably due to a form of compensation, that is to say, where we have one sorus on a pinnule the production of sporangia is greater than in cases where the sporiferous tissue is less concentrated and divided between four or five sori. Moreover, in such a specimen as that in Fig. 3, Pl. XXI. we

have a transition from a pinnule of the *racemosa* type to others of the *simplex* form. The pinna shown in Fig. 4 of the same plate recalls *S. nephrocarpa* of Bunbury, and from this type we pass by gradual transitions, marked by an increasing reduction of the lamina, to the form represented in Figs. 6 and 8, Pl. XVII. These details are more fully dealt with in the description of the individual specimens.

The same type of fertile segment is found also in some of Heer's Siberian ferns referred by him to *Thyrsopteris* and *Dicksonia*; e.g., *D. clavipes*, *T. Maakiana*, and *T. Murrayana*. Zigno's species *Hymenophyllites Leckenbyi*, from the Italian Oolite, is another form closely resembling the fertile pinnæ of *Coniopteris hymenophylloides*. Finally, Raciborski figures some fertile leaves as *Dicksonia Heerii*, which are probably identical with the English species; and his species *D. Zarecznyi* might also be reasonably referred to the same specific type.

There are several recent species with which *Coniopteris hymenophylloides* may be compared. The fertile pinnæ of *Thyrsopteris elegans*, Kze.,[1] are practically identical with some examples of the fossil species (e.g., Pl. XVII. Figs. 6 and 8; Pl. XXI. Figs. 3 and 3*a*); there is also a fairly close agreement between the sterile segments of the fossil and recent types. The fertile segments of *Dicksonia Berteroana*, Hook. (Text-fig. 13), have the same form as those of *Thyrsopteris*; the two-lipped indusium of the former is a point of difference which may be easily overlooked. It is interesting to note the striking difference between the sterile pinnæ of the *Dicksonia* shown in Text-fig. 13 and the Sphenopteroid pinnæ of *Thyrsopteris* and *Coniopteris hymenophylloides*. There can be little doubt that *Thyrsopteris elegans* may be regarded as an old type of fern which was widely distributed in Mesozoic times.

Among other recent ferns which bear a strong likeness to *Coniopteris hymenophylloides* we may mention *Dicksonia arborescens*, L'Hér., and *Balantium culcita* (L'Hér.); also some species of *Davallia*, e.g., *Davallia canariensis*, Sm., *D. Wilfordii*, Baker, etc. As illustrating a variation in the form of the fronds in the same plant, even greater than that in *Coniopteris hymenophylloides*,

[1] For figures of this fern vide Engler & Prantl (99), p. 122; Hooker (42), pl. xliv. A.

reference may be made to a figure of *Asplenium multilineatum*, Hk., given by Reinecke in a recent volume of Engler's *Jahrbücher*.[1]

An English specimen in the Lund Geological Museum, labelled by Nathorst *Sphenopteris scarbroensis*, bears a very close resemblance to *Coniopteris hymenophylloides*, and may be identical with that species. *C. hymenophylloides* is represented by numerous specimens in all collections of Yorkshire Jurassic plants.

52,568. Pl. XVI. Figs. 4 and 5.

Several pieces of pinnæ with deeply dissected pinnules, varying in size from the small and narrow form shown in Fig. 4 to the broader deltoid shape of Fig. 5. The venation is very clearly shown in some of the pinnules. These fragments appear to me identical with Brongniart's *Sphenopteris hymenophylloides*, the only difference being that in the fragment of the lower part of the pinna of Fig. 5 the segments are rather broader than in Brongniart's specimen. The pinna, of which a part only is drawn in Fig. 5, is 8 cm. in length, the uppermost pinnules being of the form illustrated in Fig. 4. The type-specimen of *Sphenopteris arguta*, L. & H., agrees exactly with the examples represented in Figs. 4 and 5; similarly, I regard the smaller pinnæ of the frond shown in Fig. 1, Pl. XX. as identical with the present specimen. This leads to a comparison with Heer's species *Thyrsopteris Maakiana*, from the Jurassic beds of Siberia,[2] a type which I believe to be identical with such English specimens as **52,568** (Pl. XVI. Figs. 4 and 5), the Whitby frond shown in Pl. XX. Fig. 1, **40,467** (Pl. XVII. Fig. 3), and others.

Scarborough. *Bowerbank Coll.*

V. 3672. Pl. XVI. Fig. 6.

The chief difference between this pinna and those of specimen **52,568** (Pl. XVI. Figs. 4 and 5) is in the more rounded form of the lobes of the segments, as shown in Fig. 6, Pl. XVI. This type of pinna is identical with those in some of the specimens referred by Brongniart to *Coniopteris Murrayana*, especially as drawn in his pl. cxxvi. fig. 3.[3] The example figured in Phillips' third

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[1] Reinecke (97), pl. iv.
[2] Heer (77), ii. pl. ii. fig. 6.
[3] Brongniart (28^2).

edition of the *Geology of the Yorkshire Coast* as *Sphenopteris affinis* is probably specifically identical with that shown in our Fig. 6.

The important point to decide is the specific identity of the fronds with pinnules like those of Fig. 6—with more or less rounded or sometimes truncate lobes—and the rather longer segments with acutely dentate lobes as represented in Figs. 4 and 5. My belief is that these two forms cannot be specifically separated; both pinnæ have the same linear form, the pinnules agree in texture and in venation, and one often finds that some of the pinnules on such specimens as that of Fig. 6 exhibit a tendency towards sharply pointed denticulations on the edges of the lobes like those in Figs. 4 and 5. There are other reasons which lead to the same conclusion, but these are stated in detail in the descriptions of the specimens shown in Plates XX. and XXI. Cf. **52,597** (Pl. XXI. Fig. 2).

52,595. Pl. XVII. Figs. 6, 7.

These fragments illustrate the association of sterile pinnules like those in **52,568** (Pl. XVI. Figs. 4 and 5) with fertile segments in which the lamina is considerably reduced and the tips of the narrow lobes bear prominent sori. The fertile portion of a pinna shown in Fig. 6 is no doubt specifically identical with *Tympanophora racemosa* of Lindley & Hutton, and with the fertile pinna attributed by Leckenby to *Sphenopteris Murrayana*; the sterile pointed segments are identical with those represented in Pl. XVI. Figs. 4 and 5, and these, as already pointed out, I regard as indistinguishable from *S. arguta*, L. & H., and *S. hymenophylloides*, Brongn., as also from those of the specimens illustrated as *S. Murrayana* in fig. 3, pl. cxxvi. of Brongniart's *Histoire*.

Bunbury's species, *S. nephrocarpa*, the type of which is in the Leckenby Collection, Cambridge, agrees with the fertile fragment shown in Pl. XVII. Fig. 6, and does not, I believe, represent a distinct species. Cf. also *Dicksonia clavipes*, as figured by Heer, from Siberia.[1]

Oolitic Shale, Haiburn Wyke.

39,266. Pl. XVII. Fig. 8.

A fertile pinna agreeing with that of Fig. 6 and with

[1] Heer (77), iv. (2), pl. ii. fig. 7.

Tympanophora racemosa. The lower pinnules, at the upper end of the drawing, are subdivided into five narrow lobes terminating in compressed cup-shaped indusia, in which some of the individual sporangia can be indistinctly recognized. The lamina of the fertile segments is rather further reduced than in **52,595** (Fig. 6). Portions of sterile pinnules of the *S. hymenophylloides* type are associated with this fertile pinna. Cf. *Thyrsopteris Murrayana* as figured by Raciborski. The fertile segments present a striking agreement with those of the recent fern *Dicksonia Bertervana*, Hk., shown in Text-fig. 13.

Scarborough. *Bean Coll.*

40,467. Pl. XVII. Fig. 3.

The pinna shown in Fig. 3 is drawn from a bipinnate frond with long acuminate pinnæ, bearing obliquely placed, narrow-pointed segments of the same form as those of Brongniart's *Sphenopteris hymenophylloides* and **52,595** (Pl. XVI. Figs. 6 and 7), but of smaller dimensions. This specimen appears to be specifically identical with Heer's Siberian examples of *Thyrsopteris Maakiana*, Heer, and with the Whitby specimen shown in Pl. XX. Fig. 1; it affords a good example of the smaller type of frond of the same habit as the larger and more abundant specimens of *S. hymenophylloides*. A specimen, identical with this, in the Leckenby Collection is labelled by Nathorst *Thyrsopteris Maakiana*, Heer.

Scarborough.

Pl. XX. Figs. 1 and 2. No. **2373**, Whitby Museum; labelled *Sphenopteris dissocialis*, Phill.

This is an important specimen as affording evidence of the specific identity of the fronds with shorter pinnules and more rounded or truncate divisions, and those of the form represented in Brongniart's figure of *S. hymenophylloides*. It affords additional evidence, in fact, in favour of regarding such pinnæ as those shown in Pl. XVI. Fig. 6 and Pl. XXI. Fig. 2 as identical with the type shown in Pl. XVI. Figs. 4 and 5 and Pl. XXI. Figs. 1 and 4. The two fronds, portions of which are drawn in Figs. 1 and 2, Pl. XX., occur close to one another on the same piece of rock, and fragments of pinnæ with shorter and more rounded segments, and others with the more pointed segments, occur indiscriminately associated together. There is also one fertile pinna like that of Figs. 6 and 8,

Pl. XVII. The apices of the pinnæ shown in Fig. 1 are identical with those of Fig. 2, and the less deeply cut and rather broader pinnules in Fig. 2 are connected with the more deeply cut segments of Fig. 1 by transitional forms met with here and there. I have no hesitation in regarding the fronds of Figs. 1 and 2 as those of one plant, or at least of one species. That shown in Fig. 1 is identical with Heer's *Thyrsopteris Maakiana*, but it is connected, by slightly larger forms, with *S. hymenophylloides*, Brongn., and with *S. arguta*, L. & H.; the frond of Fig. 2 agrees exactly with some of the published figures of *S. Murrayana*, *S. affinis*, Phill., and other 'species.' The difference between Figs. 1 and 2 is far less than one finds between fronds on the same plant of several recent ferns.

Cf. *Scleropteris tenuisecta*, Sap.[1]

39,261. Pl. XXI. Fig. 1.

This specimen illustrates a further point confirmatory of the specific identity of the fronds with sharper and longer pinnules with those bearing the more rounded and shorter segments. In this pinna the segments are of the former type, as in *S. hymenophylloides*, Brongn.; but at the base of the pinna the two lowest pinnules are curiously modified and have a form suggestive of an *Aphlebia*-type of lamina, the lamina being much more deeply cleft and the narrow linear divisions much longer and more spreading. Exactly similar *Aphlebia*-like segments are met with on pinnæ bearing the shorter and more rounded pinnules.

Cf. *Sphenopteris minutula*, Sap.[2]

Scarborough. *Bean Coll.*

52,597. Pl. XXI. Fig. 2.

This pinna is of the same type as those shown in Pl. XVI. Fig. 6 and in Pl. XX. Fig. 2. The lowest pinnule on the left-hand side exhibits a long branched segment like the *Aphlebia* form in the preceding specimen (Pl. XXI. Fig. 1).

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[1] Saporta (91), pl. lxi.

[2] Ibid. pl. lvi. Cf. also *Alloiopteris quercifolia* (Goepp.), as figured by Potonié (99), p. 139.

Pl. XXI. Figs. 3 and 3*a*. Leckenby Collection, Cambridge.

The specimen represented in Fig. 3 is shown about twice natural size; the pinna measures 2·7 cm. in length. Some of the fertile segments are exactly like those of Pl. XVII. Figs. 6 and 8, and identical with *Tympanophora racemosa*, L. & H.; the upper fertile segments, which are more reduced and have only one large cup-shaped sorus, subtended in some cases by a short bract-like sterile lobe, agree with the form referred to *Tympanophora simplex*. Another feature of interest is the same long and narrow division depending from the lowest pinnule as in the specimen shown in Figs. 1 and 2.

Fig. 3*a* shows a single enlarged sorus with indications of sporangia. Cf. *Thyrsopteris Murrayana* as figured by Heer.

52,550. Pl. XXI. Figs. 4 and 4*a*.

Part of fertile pinna, drawn twice natural size. The chief interest of this fragment is that the pinnules are only partially fertile; instead of a much reduced fertile segment with little or no lamina, we have pinnules of the ordinary sterile form bearing one or two marginal sori. The lowest pinnules have the same *Aphlebia*-like appearance—more obvious than shown in the figure—as in Figs. 1, 2, and 3.

Fragments of pinnæ of the form illustrated in both Figs. 1 and 2 of Pl. XX. occur in close association with that of Fig. 4, Pl. XXI. The manner of occurrence of a sorus is more clearly shown in Fig. 4*a*.

V. 3289. Several detached pinnæ on an iron-stained sandstone; these furnish examples of both the more rounded and the more pointed pinnules, and may be matched equally well with the pinnæ represented in Figs. 4 and 5, and with that shown in Fig. 6.

Yorkshire Coast. *Purchased.*

V. 3680 and **V. 3681.** Pinnæ with pinnules varying much in size, some being as large as those of Fig. 5, Pl. XVI. (**52,568**) and others like the lower branches of the frond represented in Pl. XX. Fig. 1. Such examples as this serve to connect *Thyrsopteris Maakiana*, Heer, on the one hand, and *Sphenopteris hymenophylloides*, Brongn., *S. arguta*, L. & H., on the other.

13,498. A long pinna with some unusually large pinnules of the type of Fig. 5, Pl. XVI.

Gristhorpe Bay. *Presented by Dr. Murray.*

39,242. Labelled by Bean *Pecopteris Murrayana*; the specimen consists of a rachis bearing long, acuminately tapering, linear pinnæ, with large pinnules intermediate in shape between the shorter and more rounded and the longer and more pointed type.

Scarborough. *Bean Coll.*

39,265. Part of a fertile pinna with pinnules identical with the type-specimen of Bunbury's *Sphenopteris nephrocarpa*, the lamina being rather less reduced than in such a form as that of Fig. 8, Pl. XVII.

Bean Coll.

39,269. An imperfect specimen labelled by Bean *Tympanophora simplex*, and no doubt identical with the form figured by Lindley and Hutton and by Phillips. The axis of the partially preserved pinna bears segments reduced to a single sorus, accompanied in some cases by a short sterile lobe, exactly as in the slightly smaller example shown in Pl. XXI. Fig. 3. The best specimen of *T. simplex* is in the Leckenby Collection, Cambridge. This shows part of a rachis with fertile pinnæ bearing pinnules with single cup-shaped sori; some of the pinnules, however, bear two or more sori, as in Pl. XXI. Fig. 3. In the typical *T. simplex* fragments the single sori are larger than the sori which are borne two, three, four, or five together on the same pinnule, and as a rule the single sorus is accompanied by a narrow sterile segment.

Lower Shale, Scarborough. *Bean Coll.*

40,467*a*. An indistinct impression on sandstone, illustrating the occurrence of a few fertile pinnules of the *Tympanophora racemosa* type with the small sterile pinnules—like those in Fig. 1, Pl. XX.—of the *Thyrsopteris Maakiana* type.

Scarborough.

52,545. Part of a fertile frond, in which the lamina of the segments is considerably reduced, but not quite so much as in the specimen shown in Fig. 8, Pl. XVII.

Lower Shale.

Other specimens:—**V. 3285** (cf. Pl. XVI. Figs. 4 and 5), **V. 3293, V. 3305, V. 3673, 13,490, 39,268, 39,276, 40,469** (the same form of frond as that from which Fig. 3, Pl. XVII. is drawn), **40,516, 48,733, 52,597***a*.

2. Coniopteris quinqueloba (Phillips).

[Geol. Yorks., 3rd ed., p. 215, lign. 33, 1875.]

(Pl. XVI. Fig. 8; Text-figs. 14 and 15.)

1875. *Sphenopteris quinqueloba*, Phillips, Geol. Yorks. p. 215, lign. 33.
S. arbuscula, var., ibid. p. 217.
1877. *Sphenopteris quinqueloba*, Lebour, Illustrations Foss. Plants, pl. xxxviii.
1892. *Sphenopteris quinqueloba*, Fox-Strangways, Tab. Foss. p. 135.

Frond tripinnate, of similar habit to that of the preceding species, but the pinnules are of smaller size and characterized by the narrow linear form of the ultimate segments. The sori and sporangia appear to be of the Cyatheaceous type.

Phillips gives the following definition of *Sphenopteris quinqueloba*: "Frond bipinnate; pinnæ long, narrow, with a slightly flexuous axis; pinnules separate, petiolate, 5-lobed, changing to 3-lobed towards the apex of the pinna."

The specimens on which this diagnosis was founded were obtained from Haiburn Wyke and Staintondale cliffs. Another species, described by Phillips as *Sphenopteris arbuscula*, also agrees closely with the specimens I have included under *Coniopteris quinqueloba*. This species is described as a tripinnate frond, with the pinnules "entirely pinnatifid, the lobes decomposed into petiolate quinquepartite leaflets, set on a flexuous axis." A smaller specimen is spoken of by Phillips as *S. arbuscula*, var.; this, I believe, is probably identical with *S. quinqueloba*: two figures are given of this variety, one of which represents the "extremity of a pinna with only the principal veins preserved," exactly as in the accompanying enlarged drawing (Text-fig. 14) of a specimen in the Manchester Museum.

In all probability *S. arbuscula*, var., and *S. quinqueloba* are specifically identical, while *S. arbuscula* may, perhaps, be referred to *S. Murrayana* (cf. Pl. XXI. Fig. 5).

In the volume of illustrations originally drawn for Lindley & Hutton and published by Lebour in 1877, a specimen is represented in plate xxxviii. which is no doubt identical with *S. quinqueloba*; it is described as *S. quinqueloba*, var. *arbuscula.* Williamson, in writing to Lindley in 1837, describes this example as "one of the most elegant little ferns I have yet seen on the Yorkshire coast."

The habit of the plant referred to *S. quinqueloba* is rather more open, and the general appearance of the deeply divided pinnules more delicate, than in the smaller forms of *Coniopteris hymenophylloides*; but the two species are undoubtedly closely



FIG. 14.—*Coniopteris quinqueloba* (Phillips). From a specimen in the Manchester Museum. (× 2.)

connected. The fragment shown in Fig. 8, Pl. XVI. illustrates the character of the sterile pinnæ, while the specimen—shown in Text-fig. 14, drawn twice natural size—affords an example of frond fragments identical with that figured by Phillips as *S. arbuscula*, var., and in which he considers the lamina has been destroyed. It is a question whether this skeleton form of a pinna represents the fertile leaf or a partially macerated frond in which only the veins have been left. We know that partially decayed fronds may assume this appearance, but it is not improbable that in this case we have the normal type of fertile pinna. Professor Nathorst, of Stockholm, generously lent me

a small specimen and drawing of a similar skeleton-like pinna, represented in Text-fig. 15, in which some of the ultimate linear segments terminate in cup-shaped indusia containing numerous sporangia apparently of the Cyatheaceous type, as shown in the figure. This example favours the view that Fig. 14 represents fertile pinnæ, in which the sori are not preserved, rather than a macerated portion of a frond of the type represented in Pl. XVI. Fig. 8. There is little doubt that *Sphenopteris quinqueloba* should be placed in the genus *Coniopteris* as a very near ally of *C. hymenophylloides*, both ferns being members of the Cyatheaceæ. Nathorst's specimen exhibits in a more delicate form the



Fig. 15.—*Coniopteris quinqueloba* (Phillips). From a drawing made from a specimen in the Stockholm Museum: both the specimen and the drawing were kindly lent by Professor Nathorst. (Fig. A × 2.)

Tympanophora racemosa type of pinna of *C. hymenophylloides*. Some of the specimens figured by Saporta from the Lower Corallian beds of France as *Stachypteris litophylla*[1] may possibly be identical with the English species.

39,263. Pl. XVI. Fig. 8.

Numerous fragments of pinnæ with small deeply lobed pinnules; the secondary pinnæ are given off at a wide angle from the secondary rachis. Labelled by Bean *Pecopteris athyroides*.

Near Scarborough. *Bean Coll.*

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[1] Saporta (73), p. 387, pl. 1.

Text-fig. 14.

These two portions of fronds have been drawn from a specimen in Manchester Museum. They agree with the fragment figured by Phillips as *S. arbuscula*, var. A few portions of sterile pinnæ which occur on the same piece of rock probably belong to this species.

Other specimens:—**V. 3291** (similar to the Manchester specimen shown in Text-fig. 14), **V. 3678, 10,317, 39,267** (cf. Text-fig. 15), **52,568** (this is similar to the fronds named by Heer *Thyrsopteris Maakiana* and the example of *Coniopteris hymenophylloides* represented in Pl. XX. Fig. 1; but the pinnules are farther apart, and the general habit of the frond is more open).

3. **Coniopteris arguta** (Lindley & Hutton).

[Foss. Flor. vol. ii. pl. cv. 1834.]

(Pl. XVI. Figs. 3 and 3*a*; Pl. XVII. Figs. 4 and 5; Text-fig. 16.)

1834. *Neuropteris arguta*, Lindley & Hutton, Foss. Flor. pl. cv.
1835. *Pecopteris acutifolia*, ibid. pl. clvii. figs. 2 and 2*b*.
Sphenopteris serrata, ibid. pl. clviii.
1836. *Cyatheites acutifolius*, Göppert, Foss. Farrn. p. 328.
Aspidites serratus, ibid. p. 363.
1838. *Pecopteris Lindleyana*, Sternberg, Flor. Vorwelt, vii. p. 153.
P. acutifolia, ibid. p. 155.
Sphenopteris serrata, ibid. p. 130.
1848. *Neuropteris arguta*, Bronn, Ind. Pal. p. 810.
Cyatheites acutifolius, ibid. p. 364.
Pecopteris serrata, ibid. p. 918.
1849. *Pecopteris arguta*, Brongniart, Tableau, p. 105.
P. serrata, ibid.
1850. *Neuropteris arguta*, Unger, Gen. spec. foss. p. 88.
Cyatheites acutifolius, ibid. p. 160.
Pecopteris serrata, ibid. p. 172.
1854. *Pecopteris Lindleyana*, Morris, Brit. Foss. p. 15.
P. acutifolia, ibid.
Sphenopteris serrata, ibid. p. 21.
1856. *Neuropteris arguta*, Zigno, Flor. foss. Oolit. vol. i. p. 126.
Pecopteris acutifolia, ibid. p. 146.
P. serrata, ibid. p. 132.
1864. *Pecopteris acutifolia*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
Sphenopteris serrata, ibid.
1869. *Alethopteris arguta*, Schimper, Trait. pal. vég. vol. i. p. 565.

1874. *Pecopteris Lindleyana*, ibid. vol. iii. p. 498.
1875. *Pecopteris Lindleyana*, Phillips, Geol. Yorks. p. 209, lign. 22.
P. serrata, ibid. p. 210, lign. 24.
P. acutifolia, ibid. p. 210.
1892. *Pecopteris arguta*, Fox-Strangways, Tab. Foss. p. 132.
P. acutifolia, ibid.

Frond tripinnate. Pinnæ linear and tapering, given off from the rachis at a wide angle; on the lower pinnæ the linear pinnules have a crenulated margin and reach a length of 1·2 cm. The smaller pinnules are entire and slightly falcate. The fertile pinnules differ in a marked degree from the sterile segments; each fertile pinnule consists of a midrib with a narrow laminar border tapering towards the apex, where it bears a circular cup-like indusium 1 mm. in diameter, with a central receptacle to which the sporangia were attached.

The drawing by the late Professor Williamson in the *Fossil Flora* of Lindley & Hutton illustrates the difference between the comparatively long and straight pinnules borne on the lower pinnæ, and the small, acutely pointed, and curved pinnules in the upper part of the frond. The ferns named by Lindley & Hutton *Pecopteris acutifolia* and *Sphenopteris serrata*, I believe to be specifically identical with their species *Neuropteris arguta*. There is a fairly close resemblance between the pinnæ of *Coniopteris arguta*, bearing small pinnules, and the pinnæ of *Klukia exilis*, but in the former species the pinnules are more acutely pointed and attached more obliquely to the pinna axis.

The name *Pecopteris Lindleyana* was applied by Presl in 1838 to a plant which he regarded as identical with *Neuropteris arguta* of Lindley & Hutton; Royle also described a fern from India under the name *Pecopteris Lindleyana*, specifically distinct from Presl's species.[1]

Presl's specific name is adopted by Phillips, who figures a specimen in which fertile and sterile pinnules are shown on the same pinna; the original of Phillips' figure is in the Leckenby Collection, Cambridge. In the absence of the characteristic fertile segments, it is practically impossible in some cases to determine the species of ferns of the *Cladophlebis* type bearing small

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[1] Royle (39), pl. ii. (Royle's type-specimen is in the Geological Department of the British Museum.)

linear pinnules. The Wealden ferns described under the names *C. Browniana* (Dunk.) and *C. Dunkeri* (Schimp.)[1] are of this type, also the specimens described by Yokoyama[2] from Japan as *Pecopteris exilis* and the specimen from Steierdorf named by Andrae *Cyatheites decurrens*.[3]

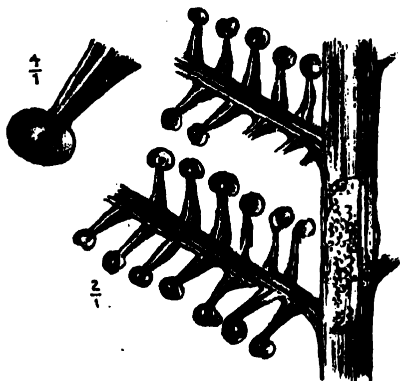


Fig. 16.—*Coniopteris arguta* (L. & H.). (No. V. 3677.)

The form of the fertile segments, especially the cup-shaped indusium, leads me to include *Coniopteris arguta* in the Cyatheaceæ. In Text-fig. 16 the fertile segments are clearly shown, twice natural size; they suggest a comparison with *Thyrsopteris* and other members of the Cyatheaceæ, and are somewhat similar to those of *Nephrolepis davallioides*, Swartz.[4] The single fertile segment, enlarged four times, shows the single *Thyrsopteris*-like indusium with the small central umbo or receptacle.

39,232. Pl. XVII. Figs. 4 and 5.

This specimen, of which a portion is represented in Fig. 4, shows parts of nine pinnæ attached to the rachis; the longest of which measures about 9 cm. The larger pinnules (Fig. 5) are

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[1] Seward (94[1]), pl. vii.
[2] Yokoyama (89), pl. i.
[3] Andrae (53), pl. vii. fig. 4.
[4] Christ (97), p. 290.

straight and slightly lobed; those nearer the distal end of the pinnæ are entire, more inclined to the pinna axis, and more acutely pointed.

Upper Shale, Scarborough. *Bean Coll.*

39,239. Pl. XVI. Figs. 3 and *3a*.

This specimen serves as an example illustrating the close agreement between portions of a frond of *Coniopteris arguta* and *Klukia exilis*. Cf. the drawing of *Pecopteris acutifolia* given by Lindley & Hutton (*Fossil Flora*, pl. clvii.).

V. 3677. Text-fig. 16.

Portions of two of the best fertile pinnæ are shown in the drawing. The fertile segments are about 4 mm. in length, and the indusial cup, with a small central receptacle, has a diameter of 1 mm. Cf. *Asplenіopteris pinnatifida*, Font.[1]

39,255. Labelled by Bean *Neuropteris arguta*. This example is probably part of a large pinna; it agrees closely with the specimen figured by Lindley & Hutton as *Sphenopteris serrata*, and forms a connecting link between the fronds with smaller pinnules and those with larger ultimate segments.

Scarborough. *Bean Coll.*

Other specimens:—**V. 2632, V. 3932, V. 3941, 13,487, 13,493, 39,232, 39,260, 40,467.**

Family DIPTERIDINÆ.

This family name is employed to indicate the probable close relationship between the recent genus *Dipteris* and such fossil genera as *Dictyophyllum* and *Protorhipis*, and to give expression to the deviation of these ferns from the typical Polypodiaceæ.

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[1] Fontaine (89), pl. xxv. fig. 6.

Genus DICTYOPHYLLUM, Lindley & Hutton.

[Foss. Flor. vol. ii. pl. civ. 1834.]

The genus *Dictyophyllum* was founded by Lindley & Hutton as a designation for a pinnatifid leaf from the Yorkshire Oolite, which they regarded as a doubtful Dicotyledon and named *Dictyophyllum rugosum*. Plants agreeing closely with this species have been placed by different authors in several genera, of which the distinguishing characteristics are by no means clear. We have, for example, the genera *Clathropteris*, *Thaumatopteris*, *Camptopteris*, *Hausmannia*, and *Protorhipis* applied to palmate fern fronds of Mesozoic age, which agree in many respects with *Dictyophyllum* and with one another. The use of these different names has not only led to much confusion, but has also considerably exaggerated the diversity which exists among the ferns referred to under the several genera.

Göppert's genus *Thaumatopteris* has been wisely included by Schenk and some other writers in *Dictyophyllum*;[1] the examination of several specimens referred to these genera in the Museums of Berlin and elsewhere has convinced me that there are no satisfactory grounds for retaining both generic names.

The genus *Clathropteris* was instituted by Brongniart in 1828[2] for a plant which he had previously described from Scania under the name *Filicites meniscoides*;[3] the most striking characteristics of this fern are its pinnatifid fronds and the regular square meshes formed by the finer veins in the lamina. The best known species of this genus is *Clathropteris platyphylla* (Göpp.),[3] of Rhætic age, the same type which Brongniart had described as *Clathropteris meniscoides*. The main distinction between *Clathropteris* and *Dictyophyllum* is the more regular and rectangular form of the meshes formed by the secondary and tertiary veins of the former, but in some fronds[4] portions of the lamina exhibit the less regular meshes characteristic of *Dictophyllum*. It would perhaps more

[1] Schenk, in Zittel (90), p. 138.
[2] Brongniart (28), p. 62.
[3] Brongniart (25), p. 207, pl. xi.
[4] E.g. Schenk (67), pl. xvii.

accurately express the affinity of the plants referred to these genera if they were regarded as generically identical, but it may be more convenient to retain the genus *Clathropteris*, as representing a fairly well defined type.

Presl instituted the genus *Camptopteris*[1] for certain ferns named by Brongniart *Phlebopteris*. The figure given by Presl of his type-specimen, *C. Muensteriana*—a plant subsequently referred to the species *Clathropteris platyphylla*—represents a small piece of frond with the venation characters of Brongniart's genus *Clathropteris*.

Another plant, named by Brongniart *Phlebopteris Nilssoni*, and included by Presl in his genus *Camptopteris*, should undoubtedly be referred to *Dictyophyllum*. While there are, I believe, no good reasons for retaining Presl's genus as originally applied, it may be convenient to retain it in the modified sense in which Nathorst has applied it to some remarkable specimens of Rhætic age from Scania.[2] A restoration published by Nathorst of *Camptopteris spiralis*, Nath., in his *Geology of Sweden*,[3] admirably illustrates the habit of the genus. Having had an opportunity of examining the Scanian fossils in the Stockholm Museum, I can bear testimony to the accuracy of Nathorst's restoration. It is probable that a specimen recently figured by Zeiller[4] as the base of a *Clathropteris* frond should be referred to the genus *Camptopteris* as used by Nathorst.[5]

Dunker's genus *Hausmannia* was instituted in 1846[6] for an imperfect leaf from the North German Wealden. The type-specimen, *H. dichotoma*, has a palmate frond, deeply divided into lobed linear segments traversed by forked main veins from which anastomosing branchlets are given off. The type-specimen of

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[1] Sternberg (38), p. 168, pl. xxxiii. fig. 9.

[2] Nathorst (78²).

[3] Nathorst (94), p. 169.

[4] Zeiller (97), pl. xxi. fig. 6.

[5] Since this was written, M. Zeiller, of Paris, has published an excellent work on Palæobotany (*Éléments de Paléobotanique*), in which he figures an unusually perfect specimen of *Clathropteris platyphylla*, Göpp., from Tonquin; this is by far the finest example so far described of a Mesozoic species which presents a striking resemblance to some forms of the recent genus *Dipteris*, and in habit agrees also with *Matonia pectinata* and *Cheiropteris palmatopedata* (Bak.).

[6] Dunker (46), p. 12, pl. v. fig. 1.

Andrae's genus *Protorhipis* was described in 1853[1] from the Jurassic rocks of Steierdorf under the name *Protorhipis Buchii*: this differs from *Hausmannia dichotoma* of Dunker in having a broader suborbicular leaf with an irregularly dentated margin. Some fossils figured by Bartholin from Bornholm as *Hausmannia Forchhammeri*[2] are in part apparently identical with Andrae's *Protorhipis Buchii*, while others agree equally well with Dunker's Wealden type. Zeiller has recently pointed out that Bartholin's specimens should be referred to *Protorhipis*,[3] and it seems clear that Andrae's genus should include fronds of the *Hausmannia dichotoma* type. As Zeiller has demonstrated by photographs and several good examples of Steierdorf specimens, the genus *Protorhipis* agrees remarkably closely with the recent genus *Dipteris*, to which it is undoubtedly very nearly related. It is convenient to retain the name *Protorhipis* for certain species of Wealden and Jurassic ferns which agree in the form of the frond with *Dipteris*, and are somewhat smaller than the typical *Dictyophyllum* fronds. While it is not difficult to distinguish between *Dictyophyllum* and *Protorhipis* in the case of good specimens, it is practically impossible to do so if we have only fragments of fronds.

If we retain *Camptopteris* in Nathorst's sense, the only other generic names of those we have mentioned which should be retained are, in my opinion, *Dictyophyllum*, *Protorhipis*, and possibly *Clathropteris*.

As Brongniart[4] long ago noticed, there is a striking similarity between the fronds of some species of *Polypodium*—referred to a special subgenus *Drynaria*—and the leaves of *Dictyophyllum*; this resemblance, however, does not extend to the habit of the frond as a whole. As regards the shape of the frond, there is a still closer resemblance between *Dipteris* and *Dictyophyllum*, and a still more striking similarity between *Dipteris* and *Protorhipis*.

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[1] Andrae (53), p. 35, pl. viii.
[2] Bartholin (92), p. 26, pls. xi. and xii.
[3] Zeiller (97), pl. xxi.
[4] Brongniart (28[1]), p. 62.

Dictyophyllum rugosum, Lindley & Hutton.

[Foss. Flor. vol. ii. pl. civ. 1833.]

(Pl. XIII. Fig. 3; Pl. XVIII. Fig. 1; Text-figs. 17–19.)

1828. *Phlebopteris Phillipsii*, Brongniart, Hist. vég. foss. p. 377, pl. cxxxii. fig. 3; pl. cxxxiii. fig. 1.
1829. *Phyllites nervulosis*, Phillips, Geol. Yorks. p. 148, pl. viii. fig. 9.
1834. *Dictyophyllum rugosum*, Lindley & Hutton, Foss. Flor. vol. ii. pl. civ.
1836. *Polypodites heracleifolius*, Göppert, Foss. Farrn. p. 344.
1838. *Dictyophyllum rugosum*, Sternberg, Flor. Vorwelt, vii. p. 133.
1848. *Dictyophyllum rugosum*, Bronn, Ind. Pal. p. 423.
1849. *Camptopteris Phillipsii*, Brongniart, Tableau, p. 105.
1850. *Polypodites heracleifolius*, Unger, Gen. spec. foss. plant. p. 167.
1854. *Dictyophyllum rugosum*, Morris, Brit. Foss. p. 7.
1856. *Dictyophyllum rugosum*, Zigno, vol. i. p. 176, pl. xxiii. figs. 2 and 2*a*.
D. Leckenbyi, ibid. p. 178, pl. xxiii. figs. 1 and 1*a*.
1864. *Dictyophyllum rugosum*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1867. *Dictyophyllum rugosum*, Schenk, Foss. Flor. Grenz. p. 144.
1869. *Dictyophyllum rugosum*, Schimper, Trait. pal. vég. vol. i. p. 634.
1875. *Phlebopteris Phillipsii*, Phillips, Geol. Yorks. p. 202, lign. 11.
P. Leckenbyi, ibid. p. 203.
1878. *Dictophyllum rugosum*, Nathorst, Foss. Flor. Schwedens, p. 15.
D. Leckenbyi, ibid.
1880. *Clathropteris whitbyensis*, Nathorst, Berättelse, p. 83.
1888. *Clathropteris whitbyensis*, Schenk, Handbuch, p. 39.
1892. *Dictyophyllum rugosum*, Fox-Strangways, Tab. Foss. p. 130.
D. Leckenbyi, ibid.
Clathropteris whitbiensis, ibid. p. 129.
1898. Cf. *Dictophyllum bremerense*, Shirley, Foss. Flor. Queensland, pl. xiii. fig. 2.

Frond large, palmate pedate, deeply dissected into broadly linear pinnatifid lobes with linear acuminate ultimate segments. Each lobe is traversed by a short midrib giving off alternate lateral veins, each of which forms the main vein of an ultimate segment; from each of the main veins smaller veins are given off approximately at right angles, and these anastomose and form a system of irregular meshes occupied by the fine ramifications of the vascular bundles. [No good examples of sori have been met with in specimens of

Dictyophyllum rugosum, but in other species the sporangia are described as having a complete vertical or oblique annulus and tetrahedral spores.[1]]

In 1828 Brongniart proposed the name *Phlebopteris Phillipsi* for the plant figured by Lindley & Hutton in 1834 as *Dictyophyllum rugosum*; the latter name is quoted by the French author as a synonym, although the plant was not described in the *Fossil Flora* until 1834. We must assume, therefore, that Brongniart saw the description by the English authors some years before Lindley & Hutton published their work. The name *Dictyophyllum rugosum* has been usually accepted, and, apart from the question of strict priority, it is adopted as the better known and more convenient designation. In a later work, Brongniart[2] expressed the opinion that the English species should probably be referred to Presl's genus *Camptopteris*.

In 1856 Zigno instituted a new specific name, *Dictyophyllum Leckenbyi*, for a *Dictyophyllum* frond from the Yorkshire coast, with deeply pinnatifid pinnæ having long and narrow ultimate segments, which he regarded as distinct from *D. rugosum*. The difference between such a leaf as that shown in pl. xxiii. of Zigno's work and Williamson's drawing published by Lindley & Hutton, consists chiefly in the longer and narrower segments of the former, but the existence of transitional forms affords ample evidence of the specific identity of the two forms. In 1878 Nathorst[3] discussed at some length the genus *Dictyophyllum*, and quoted the species as characterized by very variable leaves and as illustrating the difficulty of distinguishing between species and varieties.

The relationship of *Dictyophyllum rugosum* with recent ferns is of considerable interest. The genus *Dictyophyllum* has been quoted as a leptosporangiate fern agreeing in certain characters with both the Gleicheniaceæ and Cyatheaceæ,[4] and in that respect comparable with *Matonidium* and *Laccopteris*. Some of the more perfect specimens of *Dictyophyllum* certainly suggest a comparison,

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[1] Schenk (67), pl. xvi.
[2] Brongniart (49), p. 32.
[3] Nathorst (78[2]), p. 13.
[4] Solms-Laubach (91), p. 154.

as regards the form of the frond, with *Matonia pectinata*, R. Br., but the soral characters and the form of the leaf point rather to a comparison with the genus *Dipteris*. *Dipteris*[1] is a tropical Indo-Malay type represented at the present day by a few species, which have usually been placed among the Polypodiaceæ, but the sporangia do not appear to be typically polypodiaceous, and the genus is clearly an isolated type of somewhat uncertain position. Raciborski[2] has suggested the new family term Protopolypodiaceæ for the reception of a fertile *Dictyophyllum* leaf characterized by naked sori, consisting of a few sporangia with an oblique annulus, characters which are found also in the recent species of *Dipteris*. It is proposed to discuss more fully elsewhere the systematic position of the recent genus, but such evidence as we at present possess favours the view that *Dictyophyllum* and *Protorhipis* are closely related to *Dipteris*, and constitute Mesozoic members of a group of ferns now barely represented, but in former times widely distributed. It may be convenient to emphasize the affinity of *Dictyophyllum* with *Dipteris*, and the isolated position of both these genera and *Protorhipis*, by placing them provisionally in a separate family, which we may designate the Dipteridinæ, using in a wider sense a term already employed with a more restricted meaning.

39,224. Pl. XIII. Fig. 3.

Portions of two pinnæ which are so placed as to suggest their proximity to a common rachis towards which they are converging. The whole frond probably had a habit similar to that of *Matonia pectinata*, *Cheiropteris*, *Laccopteris*, and other genera. The single segment represented in the figure is given off practically at right angles from the axis of the pinna, and represents a portion of a long and narrow segment with irregularly dentate or undulating margins, similar to the form of leaf named by Zigno *Dictyophyllum Leckenbyi*. The venation characters are fairly well shown in the figured specimen. Labelled *Phlebopteris Phillipsii* in Bean's MS.

Gristhorpe. *Bean Coll.*

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[1] Engler & Prantl (99), p. 202, fig. 108. Vide also Beddome (66), pl. lxxx.
[2] Raciborski (91), p. 8. Vide also Potonié (99), p. 86.



Fig. 17.—*Dictyophyllum rugosum* (L. & H.). From a specimen (No. 2360) in the Whitby Museum. (Nat. size.)

V. 2724. Pl. XVIII. Fig. 1.

A good specimen representing the apical portion of a pinna; at the apex the pinna is strongly dentate, and the pointed entire segments become rapidly longer towards the lower part of the leaf, which may be described as pinnatisect with linear tapering segments. The whole specimen has a length of 17·5 cm., but the lowest part is not shown in the figure. Prominent lateral veins are given off from the central axis of the pinna, and from these arise smaller anastomosing veins.

The segment shown in Fig. 3, Pl. XIII. is, in all probability, specifically identical with the present specimen, and belongs to the lower part of a deeply dissected pinna, of which Fig. 1, Pl. XVIII. represents the apical portion. *Beckles Coll.*

Text-fig. 17 (Whitby Museum, No. 2360).

This unusually good specimen from the Whitby Collection is no doubt the one referred to by Nathorst[1] in his notes on the Jurassic Flora of England; he compares it with *Clathropteris platyphylla*, Brongn., and adopts the name *C. whitbiensis*, which Brongniart suggested, but never published, for the Whitby specimen.

A comparison of specimen **V. 2724** (Pl. XVIII. Fig. 1) with Text-fig. 17 at once brings out the close agreement between one of the dentate divisions of the frond shown in the figure and the portions of a pinna represented in Fig. 1, Pl. XVIII. The Whitby specimen is an example of a comparatively small frond clearly illustrating the characteristic method of branching of the main veins, which agrees with that in the recent genus *Dipteris*. The commoner specimens of *Dictyophyllum* are merely portions of pinnæ or the ultimate segments of pinnæ.

The spotted appearance shown in Fig. 17 is due to the presence of small patches of carbon; no definite trace of sporangia can be detected.

V. 2891. Text-fig. 18.

An imperfectly preserved frond similar to the Whitby specimen (Fig. 17), but without the lower portion of the leaf where the several pinnæ converge into a common lamina traversed by radiating

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[1] Nathorst (80[1]), p. 83.



FIG. 18.—*Dictyophyllum rugosum* (L. & H.). No. V. 2891. (Nat. size.)

main ribs. Both the specimens (Figs. 17 and 18) represent young, or at least small, leaves; the examples of the form represented in Pl. XIII. Fig. 3 belong to much larger leaves.



Fig. 19.—*Dictyophyllum rugosum* (L. & H.). From a specimen in the Leckenby Collection, Cambridge (No. 135). (Nat. size.)

Text-fig. 19. Leckenby Collection, Cambridge (No. 135).

This specimen is very similar to that of Fig. 17, but interesting as showing part of the main framework of a frond with indistinct traces of the laminar portion, in which the secondary and tertiary veins are sufficiently indicated to enable one to recognize the *Dictyophyllum* characters. Identified by Phillips in 1873 as *Phlebopteris Phillipsi.*

V. 2523. Two specimens on the same piece of rock; one of them is from the basal portion of a frond, and shows three main ribs converging towards a common point, as seen in Text-figs. 17–19. The segments of the other specimen have the long and narrow form similar to that of **39,224** (Pl. XIII. Fig. 3).

Upper Shale, Gristhorpe. *Presented by Mr. J. Williamson.*

13,508. In this example the upper portion of the pinna consists of a narrow lamina with dentate edges, similar to the segment shown in Pl. XIII. Fig. 3; in the lower part the pinna bears long and narrow segments. Cf. **V. 2891** (Text-fig. 18).

39,223. A large specimen about 25 cm. in length. In the lower portion the pinnæ are deeply pinnatisect; the segments extend almost to the rachis, as in pl. civ. of the *Fossil Flora* of Lindley & Hutton; the segments are rather far apart, as in the *Dictyophyllum Leckenbyi* form of frond, and they have a crenulate margin. The longest ultimate segment measures 10·5 cm. in length. In the upper part of the specimen the segments become gradually shorter, and the lamina connecting the bases of the segments is broader than in the lower part of the pinna. The margin of the shorter and smaller segments in the upper part of the pinna is entire, agreeing with those of **V. 2724** (Pl. XVIII. Fig. 1). A specimen of this form serves to illustrate the identity of Zigno's *D. Leckenbyi* with *D. rugosum* of Lindley & Hutton. Labelled by Bean *Phlebopteris Phillipsii*, *Phyllites nervulosus*, and *Dictyophyllum rugosum*.

Gristhorpe Bay. *Bean Coll.*

Other specimens: — **V. 3669** and **10,370** (similar to **39,224**; venation clearly shown).

Family SCHIZÆACEÆ.

Genus **KLUKIA**, Raciborski.

[Engler's Jahrb. vol. xiii. p. 1, 1891.]

The genus *Klukia* was instituted by Raciborski as a substitute for *Pecopteris* in the species *P. exilis*, Phill., on the ground that the sporangial characters proved the fern to be a member of the Schizæaceæ; a new name was, therefore, wisely chosen to mark a fuller knowledge of botanical affinity than is expressed by the form-genus *Pecopteris*.

Klukia is a genus characterized by the manner of occurrence and structure of the sporangia as well as by the *Pecopteris* or *Cladophlebis* form of the frond; the sporangia possess an apical annulus, and occur singly on either side of the midrib of the ultimate segments.

In 1851 Bunbury[1] figured a fragment of a fertile pinna of *Pecopteris exilis*, and drew attention to the agreement between the fossil sporangia and those of the Schizæaceæ. Bunbury's specimen, which is now in the Cambridge Botanical Museum, has been refigured to show more clearly the structure of the sporangia.[2] Other figures of this species may be found in Raciborski's paper already referred to, and in the Monograph of the Cracow Flora by the same author.

It is of interest to note that the type of sporangium characteristic of the Schizæaceæ is met with also among Palæozoic ferns; the well-known genus *Senftenbergia* of Corda[3] is characterized by the possession of sporangia with an apical annulus consisting of two rings of thick-walled cells, while the recent species have usually one ring only. In a recent publication Zeiller has shown that in the sporangia of *Lygodium* a second ring of thick-walled cells is occasionally represented; a fact which connects more closely the Palæozoic type and the recent species.[4] A similar example of a recent *Lygodium* sporangium, with an indication of a double annulus, was figured by Link in 1842.[5]

Klukia exilis (Phill.).

[Geol. Yorks. p. 148, pl. viii. fig. 16, 1829.]

(Pl. XVI. Fig. 7.)

1829. *Pecopteris exilis*, Phillips, Geol. Yorks. p. 148, pl. viii. fig. 16.
1836. *Cyatheites obtusifolius*, Göppert, Foss. Farrn. p. 328.
1837. *Pecopteris obtusifolia*, Lindley & Hutton, Foss. Flor. vol. iii. pl. clviii. fig. 1.

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[1] Bunbury (51), p. 188, pl. xiii. fig. 5.
[2] Seward (94[2]), p. 197.
[3] Corda (45), p. 91.
[4] Zeiller (97[2]), pp. 215 and 216. Vide also Bower (99), p. 43.
[5] Link (42), pl. iv. fig. 2.

1838. *Pecopteris obtusifolia*, Sternberg, Flor. Vorwelt, fasc. vii. p. 155.
1848. *Pecopteris exilis*, Bronn, Ind. Pal. p. 915.
1850. *Cyatheites obtusifolius*, Unger, Gen. spec. foss. p. 159.
1851. *Pecopteris exilis*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 188.
1854. *Pecopteris exilis*, Morris, Brit. Foss. p. 15.
1856. *Pecopteris exilis*, Zigno, Flor. foss. Oolit. vol. i. p. 144.
1864. *Pecopteris exilis*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1869. *Pecopteris exilis*, Schimper, Trait. pal. vég. vol. i. p. 536.
1875. *Pecopteris exilis*, Phillips, Geol. Yorks. p. 210, pl. viii. fig. 16.
1891. *Klukia exilis*, Raciborski, Engl. Jahrb. vol. xiii. p. 1.
1892. *Pecopteris exilis*, Fox-Strangways, Tab. Foss. p. 132.
1894. *Klukia exilis*, Seward, Proc. Phil. Soc. Camb. vol. viii. p. 197.
K. exilis, Raciborski, Flor. Krakow. p. 165, pl. vii. fig. 13; pl. viii. figs. 1–3, 7 (?), 8, and 9*b*; pl. ix. figs. 1 and 2 (?); pl. xxvi. fig. 1 (?).
K. exilis, var. *parvifolia*, ibid. p. 167; pl. viii. fig. 6; pl. xxvi. fig. 2.
K. acutifolia, ibid. p. 168, pl. vii. figs. 10–12 and 18.
K. Phillipsii, ibid. p. 169, pl. viii. figs. 4 and 5; pl. vii. fig. 16.

Type-specimen. ? York Museum.

Frond tripinnate, of the *Cladophlebis* type; the pinnæ are alternate and linear, lanceolate in form; attached to the rachis at a wide angle. The ultimate segments are short and linear, with more or less bluntly rounded apices, seldom exceeding 5 mm. in length; the sporangia, which may reach a length of ·5 mm., are borne singly on the under side of the pinnules, forming a single row on each side of the midrib.

It is difficult to distinguish some of the sterile bipinnate fronds of this type from the fern described by Lindley & Hutton as *Sphenopteris serrata*. Nathorst considers the two forms specifically identical, but I believe that the latter fern should be included in *Neuropteris arguta* of Lindley & Hutton.

Raciborski's figures of the specimens he refers to *Klukia acutifolia*, *K. exilis*, and *K. Phillipsi* do not afford satisfactory evidence of specific difference; it is probable that the examples so named are all referable to Phillips' species.

There are several good examples of *Klukia exilis* in the Leckenby Collection, Cambridge, and in the Museums of Manchester, Scarborough, and other places.

40,557. Pl. XVI. Fig. 7.

A portion of a bipinnate fertile frond; the narrow linear pinnæ are given off from the rachis at a wide angle. The pinnules,

which are attached to the pinna axis by the whole of the base, have an entire margin and blunt apices. On the under side of the pinnules a row of pits, representing the large single sporangia, occurs on each side of the midrib.

Oolite Shale, Scarborough. *Bowerbank Coll.*

V. 3671. A small and imperfect specimen, but of interest as agreeing very closely with Phillips' figure,[1] which evidently represents a badly preserved fragment.

Gristhorpe Bay.

V. 3676. Part of a frond in which the pinnules are longer than usual, having a length of 5 mm. and bearing seven sporangia on each side of the midrib. The apical annulus is clearly shown.

13,496. Portions of two bipinnate pinnæ, which by their manner of occurrence on the shale appear to belong to a tripinnate frond.

Gristhorpe Bay. *Presented by Dr. Murray.*

39,244. Portions of two bipinnate pinnæ, one of which is attached to the main rachis. The sporangia appear on the upper surface of the pinnules as three to five circular projections on each side of the midrib. Labelled by Bean *Pecopteris obtusifolia.*

Upper Shale, Scarborough. *Bean Coll.*

39,241. A large specimen labelled by Bean *Pecopteris obtusifolia* and *P. exilis.*

Genus **RUFFORDIA**, Seward.

[Brit. Mus. Catalogue; Wealden Flora, vol. i. p. 75, 1894.]

The generic name *Ruffordia* was substituted for the provisional genus *Sphenopteris*, because the evidence afforded by the rich Wealden material seemed to justify the inclusion of Dunker's species, *Sphenopteris Goepperti*, in the Schizæaceæ; the new name was suggested as indicating a less imperfect knowledge of affinity than is implied by the generic term *Sphenopteris.* The genus is

[1] Phillips (29), pl. viii. fig. 16.

characterized by a distinct contrast between barren and fertile pinnæ, by the resemblance of the pinnules to those of *Anemia adiantifolia*, Sw., and by the correspondence in habit of both the sterile and fertile pinnæ.

Ruffordia Goepperti (Dunker).

[Wealdenbildung, p. 4, pl. i. fig. 6; pl. ix. figs. 1–3, 1846.]

The synonymy and diagnosis of this species have been given at length in the first volume of my *Wealden Catalogue*. Leckenby was the first to suggest the identity of the Lower Oolite fern with the Wealden species which Ettingshausen named *Sphenopteris Jugleri*. Schenk included *Sphenopteris Jugleri*, Ett., as a synonym of Dunker's species *S. Goepperti*, and the Wealden specimens in the British Museum amply confirm this view. There are no examples from the Yorkshire Oolite rocks in the Museum Collection which can be referred to the Wealden type, but in the Leckenby Collection (Cambridge) there are two small specimens (Nos. 144, 158) which are probably identical with *Ruffordia Goepperti*. In the third edition of Phillips' *Geology of Yorkshire* there is a figure[1] of a portion of one of the Leckenby specimens which does not do justice to the original, but it serves to illustrate the resemblance of the Jurassic fern to the Wealden type.

The list of Inferior Oolite fossils given by Fox-Strangways[2] includes the Wealden species *Sphenopteris Jugleri*, Ett. On the smaller specimen in the Leckenby Collection Nathorst has written: "Possibly the young leaf of *Sphenopteris Williamsonis*, or perhaps the same as *S. Jugleri*." The larger specimen (No. 158) bears but little resemblance to Brongniart's species *S. Williamsonis*.

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[1] Phillips (75), p. 218, lign. 40.
[2] Fox-Strangways (92[2]), p. 135.

Family ? POLYPODIACEÆ.

Genus **CLADOPHLEBIS**, Brongniart.

[Tableau, p. 25, 1849.]

1. Cladophlebis denticulata (Brongn.).
[**2. Cladophlebis lobifolia** (Phillips).
3. Cladophlebis haiburnensis (Lindley & Hutton).]

The species *Cladophlebis denticulata* (Brongn.) is included in the family Polypodiaceæ on the ground that the fertile pinnules agree fairly closely with those of some recent polypodiaceous ferns, but the evidence is insufficient to admit of a positive statement as to systematic position. The other two species of the genus must still be included among the ferns which do not afford any trustworthy evidence as to family affinities.

1. **Cladophlebis denticulata** (Brongniart).

[Hist. vég. foss. p. 301, pl. xcviii. figs. 1, 2, 1828.]

(Pl. XIV. Figs. 1, 3, 4; Pl. XV. Figs. 4 and 5; Pl. XX. Figs. 3 and 4.)

1828. *Pecopteris denticulata*, Brongniart, Prodrome, p. 57.
P. denticulata, Brongniart, Hist. vég. foss. p. 301, pl. xcviii. figs. 1 and 2.
P. Phillipsii, Brongniart, ibid. p. 304, pl. cix. fig. 1.
P. Phillipsii, Brongniart, Prod. p. 57.
Phlebopteris? undans, Brongniart, Hist. vég. foss. p. 375, pl. cxxxiii. fig. 3.
1833. *Neuropteris ligata*, Lindley & Hutton, Foss. Flor. pl. lxix.
1834. *Pecopteris undans*, ibid. pl. cxx.
P. insignis, ibid. pl. cvi.
P. whitbiensis, ibid. pl. cxxxiv.
1836. *Polypodites undans*, Göppert, Foss. Farrn. p. 345.
Alethopteris insignis, ibid. p. 307.
A. Phillipsii, ibid. p. 304.
1838. *Pecopteris? undans*, Sternberg, Flor. Vorwelt, fasc. vii. p. 161.
P. insignis, ibid. p. 151.
P. denticulata, ibid. p. 157.
Neuropteris ligata, ibid. p. 76.
Pecopteris Phillipsii, ibid. p. 150.

1848. *Alethopteris insignis*, Bronn, Ind. Pal. p. 23.
A. denticulata, ibid. p. 23.
Neuropteris ligata, ibid. p. 811.
Alethopteris Phillipsii, ibid. p. 24.
1849. *Polypodites undans*, Brongniart, Tableau, p. 105.
Pecopteris denticulata, ibid.
Cladophlebis ligata, ibid.
Pecopteris Phillipsii, ibid.
1850. *Polypodites undans*, Unger, Gen. spec. foss. p. 168.
Alethopteris insignis, ibid. p. 149.
Neuropteris ligata, ibid. p. 86.
Alethopteris Phillipsii, ibid. p. 148.
1854. *Pecopteris insignis*, Morris, Brit. Foss. p. 15.
P. denticulata, ibid.
P. ligata, ibid.
P. Phillipsii, ibid. p. 16.
1856. *Polypodites undans*, Zigno, Flor. foss. Oolit. vol. i. p. 164.
Pecopteris insignis, ibid. p. 135.
P. denticulata, ibid. p. 129.
P. ligata, ibid. p. 140.
P. Phillipsii, ibid. p. 129.
1863. ? *Pecopteris indica*, Oldham & Morris, Pal. Ind. p. 47, pl. xxvii.
1864. *Polypodites undans*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
Pecopteris insignis, ibid.
Neuropteris ? ligata, ibid.
Pecopteris whitbiensis, ibid. p. 77.
1868. *Alethopteris insignis*, Eichwald, Leth. Ross. pl. ii. fig. 6, p. 15.
1869. *Alethopteris insignis*, Schimper, Trait. pal. vég. vol. i. p. 565.
A. denticulata, ibid. p. 563.
A. Phillipsii, ibid. p. 564.
Cf. *Pecopteris australis*, McCoy, Geol. Surv. Vict. p. 16, pl. xiv. fig. 3.
1875. *Phlebopteris undans*, Phillips, Geol. Yorks. p. 203, lign. 12.
Pecopteris insignis, ibid. p. 206, lign. 17.
P. denticulata, ibid. p. 206, lign. 18.
P. Phillipsii, ibid. p. 207, lign. 19.
1877. ? *Asplenites macrocarpus*, Feistmantel, Pal. Ind. (77[1]) p. 171, pl. i. fig. 1; pl. xlviii. fig. 2, etc.
Alethopteris indica, Feistmantel, Pal. Ind. (77[2]) pl. i. figs. 3–5.
1878. *Asplenium petruschiniense*, Heer, Flor. foss. Arct. vol. v. (ii.) pl. i. fig. 1.
1882. *Pteris frigida*, Heer, Flor. foss. Arct. vol. vi. p. 27, pl. x. figs. 1–4; pl. xi.; pl. xii. fig. 2; pl. xiii. fig. 2; pl. xvi. figs. 1 and 2.
P. longipennis, ibid. pl. x. figs. 11 and 12; pl. xiii. fig. 1.
P. ligata, ibid. pl. xvi. fig. 3.
1889. *Cladophlebis denticulata*, Fontaine, Potomac Flora, p. 71, pl. vii. fig. 7.
1890. Cf. *Alethopteris australis*, Feistmantel, Foss. Flor. Australia, pl. xxvii. fig. 3.
1892. *Pecopteris undans*, Fox-Strangways, Tab. Foss. p. 133.
P. denticulata, ibid. p. 132.

1892. *Asplenium whitbiense*, ibid. p. 129.
? *Cladophlebis falcata*, Dawson, Trans. Roy. Soc. Canada, p. 84.
1894. *Cladophlebis denticulata*, Raciborski, Flor. Krakow. p. 224, pl. xxii. figs. 3 and 4.
C. cf. *nebbensis*, ibid. p. 227, pl. xxii. figs. 5 and 6.
C. insignis, ibid. p. 223, pl. xxii. figs. 9 and 10.
1896. Cf. *Cladophlebis Roesserti Groenlandica*, Hartz, Med. Grön. pls. vii.–x.
C. Stewartiana, ibid. pl. xi. figs. 1 and 2.
Asplenites, sp., ibid. pl. xi. fig. 3.
1900. *Cladophlebis denticulata*, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 18, pl. iv. fig. 9.

Type-specimens. Brongniart's type-specimens in the Paris Museum. A specimen, which is the counterpart of the type-specimen of *Pecopteris insignis* of Lindley & Hutton, is in the Leckenby Collection, Cambridge (No. 342).

Frond bipinnate, large, with long spreading pinnæ attached to a comparatively slender rachis. Pinnules falcate, acutely pointed, usually finely dentate, attached by the whole of the base; the longest pinnules may reach a length of 3–4 cm. Venation of the typical *Cladophlebis* type; a well-marked midrib giving off secondary dichotomously forked veins at an acute angle. Towards the apex of the frond the pinnules are shorter and broader than the longer and narrower segments in the lower or middle portion of the frond.

Fertile fronds similar in form to the sterile; the segments of the same shape, but somewhat straighter, and with an irregularly serrate margin, the sori are oblong in shape and parallel to the secondary veins.

The specimens on which Brongniart founded his species *Cladophlebis denticulata* are fairly large examples of well-preserved fronds with falcate pinnules having an obviously dentate margin; they are of the same form as those represented in Pl. XIV. Figs. 3 and 4 of this Catalogue. Brongniart regards *Pecopteris ligata* of Phillips and *Neuropteris ligata*, as figured by Lindley & Hutton, as identical with his *P. denticulata*. The type-specimens of *P. denticulata* were sent to Paris by Williamson and Bean from the neighbourhood of Scarborough (no doubt Gristhorpe Bay).

The frond represented in the *Fossil Flora* of Lindley & Hutton as *Neuropteris ligata* has falcate dentate pinnules like those in Brongniart's specimen, and as shown in Pl. XIV. Fig. 3. Nathorst, who has examined the type-specimen of *Pecopteris ligata* of

Phillips in the Oxford Museum, believes it to be a fragment of *Laccopteris polypodioides*[1] (Brongn.), but he regards *Neuropteris ligata*, L. & H., as identical with *Cladophlebis denticulata.*[2] The same author considers that *Pecopteris insignis* of Lindley & Hutton is probably the lower part of a frond of *P. denticulata*, Brongn. This view is no doubt correct. The drawing in the *Fossil Flora* (pl. cv.) represents the long falcate pinnules as entire, but a close inspection of the type-specimen (or rather the counterpart, now in the Leckenby Collection, Cambridge, No. 342) reveals the presence of fine teeth on the more perfectly preserved segments. Nathorst has also suggested that the fragments figured by Lindley and Hutton and others as *Pecopteris* or *Phlebopteris undans* may belong to a fertile frond of *Cladophlebis denticulata*. A careful comparison of several specimens of *P. undans* with *C. denticulata* has led me to this conclusion (vide Pl. XX. Figs. 3*a* and 3*b*). The type-specimen of *P. undans* of Lindley & Hutton (Scarborough Museum) is associated with portions of *Cladophlebis denticulata* on the same piece of shale.

Schimper and some other authors have also considered *Neuropteris ligata* of Lindley & Hutton and *Cladophlebis denticulata* (Brongn.) identical.

It has already been pointed out, in the description of *Todites Williamsoni*, that the specimens described by Brongniart as *Pecopteris whitbiensis* appear to be identical with the former species and specifically distinct from the type-specimen of *P. whitbiensis* as figured by Lindley & Hutton. It would be a hopeless task to attempt an accurate determination of the numerous fronds or fragments of pinnæ referred by various authors to *Pecopteris whitbiensis*, *Asplenium whitbiense*, etc., but it is at least highly probable that not a few of the fossils thus described are specifically identical with *Cladophlebis denticulata*, Brongn. Fern fronds of the type described under such names as *Cladophlebis whitbiensis*, *C. Albertsii*, *Asplenium Roesserti*, *A. nebbense*, etc., have a worldwide distribution in Mesozoic rocks,[3] and we know that leaves of a precisely similar habit are met with in different

[1] Nathorst (80[1]), p. 60.
[2] Ibid. p. 58.
[3] Seward (94[1]), p. 95.

genera and families of recent ferns; an identification of fossil fragments of this type without the evidence of fertile pinnæ is a hopeless task. All that we can do, is to point out what appear to be the most probable cases of identity among the numerous examples of fronds of this type in the English Jurassic strata and in beds of approximately the same age in other countries.

Zigno includes *Pecopteris whitbiensis*, L. & H., as a synonym of *P. ligata*, Phill. The pinnules as represented in pl. cxxxiv. of the *Fossil Flora* (*P. whitbiensis*) have entire margins, but are otherwise identical with those of *Neuropteris ligata* of Lindley & Hutton. The small portion of a pinna figured in Pl. XV. Fig. 5 of this volume is taken from a fairly large specimen of a frond which is labelled by Bean *Pecopteris whitbiensis* (No. **39,240**), and agrees exactly with the frond illustrated under this name by the authors of the *Fossil Flora*. I believe that *P. denticulata* of Brongniart and *P. whitbiensis* of Lindley & Hutton are specifically identical.

The specimens figured by Lindley & Hutton as *Pecopteris dentata* have been incorporated under the species *Todites Williamsoni*, as a result of the examination of the type-specimens.

Brongniart's figure of *Pecopteris Phillipsii*, drawn from a specimen contributed by Williamson from Cayton, near Scarborough, presents a fairly close agreement with some forms of *Cladophlebis denticulata*, and is clearly identical with the example represented in Pl. XX. Fig. 4; this specimen has been labelled by Bean *Pecopteris Phillipsii*, Brongn. The somewhat narrower form of the pinnules and other slight differences between this form of frond and the more typical *C. denticulata* are, I believe, of no importance; they rather suggest that the frond had been exposed to the sun some time and slightly contracted or shrivelled before it was embedded in the mud.

Enough has been said to indicate the confused state of the synonymy of these *Cladophlebis* fronds.

Brongniart's specific name *denticulata* is adopted as having been published earlier than *C. insignis* of Lindley & Hutton, and as denoting a type of frond of common occurrence in collections of Yorkshire Oolite plants. To use the specific name *whitbiensis* would lead to considerable confusion, as different authors have applied this designation to fern fronds belonging to distinct genera and different families.

Before referring to other authors whose determinations are mentioned in the above synonymy, it may be a convenience to concisely summarize the conclusions to which an examination of the East Yorkshire *Cladophlebis* fronds has led me.

In the first place it seems almost certain that *Pecopteris undans* as figured by Lindley & Hutton and others is, as Nathorst suggested, the fertile frond of *Cladophlebis denticulata*. Further reference is made to this point elsewhere. The comparison of such specimens as that figured by Lindley & Hutton as *Pecopteris insignis*, the example represented in Pl. XIV. Fig. 1 (**39,236**), and many others, with specimens like that shown in Pl. XIV. Fig. 3, and as figured by authors under such names as *Neuropteris* or *Pecopteris ligata*, *P. whitbiensis*, etc., in which the pinnules are smaller, has convinced me of the identity of the fronds possessing larger and smaller ultimate segments. The prominence or almost complete absence of denticulations on the margin of the pinnules are characters of slight importance. In some cases, as an examination of type-specimens has shown, segments with a finely dentate border have been erroneously represented in drawings as pinnules with an entire margin. In one or two specimens in the National Collection and other museums the pinnules appear to be entire, but in other respects the fronds cannot be separated from those with dentate pinnules. To lay stress on such a point as this would be to magnify a character of very small importance to the rank of a specific difference; my impression is that on a large frond of the fern *Cladophlebis denticulata*, we might well find some pinnules with entire and others with a denticulate border. Brongniart's species *Pecopteris Phillipsii*, as already suggested, is probably a somewhat imperfect example of *C. denticulata*.

There are certain species of fronds of the *Cladophlebis* type figured by several authors from Jurassic horizons which present a close agreement with *C. denticulata*, but which cannot with safety be included in a list of synonyms. In Schenk's admirable work on the flora of the strata between the Keuper and the Lias of Franconia a frond is figured as *Asplenites Roesserti* (Presl); the drawing of this species in Schenk's pl. x. fig. 1[1] agrees very closely with specimen No. **39,238** in the British Museum Collection, and still more closely with a specimen in the Leckenby Collection

[1] Schenk (67).

from the Yorkshire Oolites. In Schenk's figure we have the apical portion of a frond, which is characterized by the open habit of the pinnæ and by the rather short and broad form of the pointed pinnules; at the tip of the frond the pinnæ are gradually replaced by single falcate segments. The striking similarity leads me to regard the German and English plants, although from different geological horizons, as nearly allied, if not indeed identical. Another specimen illustrated in Schenk's monograph, and named *Asplenites ottonis*,[1] agrees in habit with *A. Roesserti*, but differs in the appearance of the pinnules, which are fertile, and present a corrugated surface due to the presence of sori parallel to the secondary veins; these are precisely the characters of the fertile pinnæ of *C. denticulata* (*Pecopteris undans*). It may be suggested that *Asplenites ottonis* is the fertile form of the frond referred by Schenk to *A. Roesserti*; the very small fragment of the latter species described by the same author as fertile is very imperfect and far from clear. While speaking of the fertile pinnules, a comparison may be made also with some fragments figured by Heer from Siberia, and referred by him to *Asplenium whitbiense*; these possess long sori apparently with indusia disposed obliquely to the midrib and parallel to the secondary veins, as in *Pecopteris undans*. It is unfortunately impossible to make out the exact form of the sori in the English specimens or to decide on the presence or absence of an indusium, but so far as it is possible to judge, it would appear that the sori may have been of a type similar to that shown in Heer's figures, and to such as we find in some recent Polypodiaceous species.

In addition to the species *Pteris frigida* and *P. longipennis* figured by Heer from Greenland, and included in the above list as most probably specifically identical with *Cladophlebis denticulata*, there are some other fragments of fronds referred by the same author to *Pecopteris argutula*, *Aspidium Oerstedi*, and other species, which may be identical with *C. denticulata*; but it is impossible to decide as to the affinities of many of these fronds. It is not improbable that the Australian fern named by McCoy[2] *Pecopteris australis*, and compared by him with the English type, which Bean named *P. scarburgensis*, is identical with that species.

[1] Schenk (67), pl. xi.
[2] McCoy (74), p. 16, pl. xiv. fig. 3.

Bean's name *Pecopteris scarburgensis* was applied by him to specimens clearly identical with *C. denticulata*.

In Fontaine's *Potomac Flora* there are several specimens named *Cladophlebis falcata*;[1] these have the same form of frond as *C. denticulata*, but there is hardly enough evidence, without having access to the specimens, to warrant the inclusion of the Potomac species among the synonyms of Brongniart's plant. Fontaine also figures some fronds which he names *C. denticulata*, but speaks of this species as new, while drawing attention to published figures of *Pecopteris denticulata* by Heer.[2]

A specimen in the British Museum Collection (**V. 640**) from Steierdorf im Banat, named *Pecopteris whitbiensis*, bears a very close resemblance to *Cladophlebis denticulata*, but the pinnules appear to have an entire margin. There are various other fossil fronds which may be compared with *Cladophlebis denticulata*, e.g. *Asplenium distans* as figured by Yokoyama[3] from Japan; but without more trustworthy evidence than a similarity in the form of the sterile pinnæ there must always be an element of uncertainty in our comparisons.[4]

The point of most interest as regards the comparison of *Cladophlebis denticulata* with recent ferns is the evidence afforded by the nature of the fertile pinnules of the fossil species. We know nothing as to the structure of the sporangia, and our comparisons must rest solely on the form of the fertile segments and the disposition of the sori. It is among the Polypodiaceæ that we find the nearest resemblance to the fossil species; in some species of *Asplenium*, e.g. *A. lugubre*,[5] also *Phegopteris decussata* (L.),[6] the fertile pinnules with their thin linear sori parallel to the lateral veins agree closely with those of *Cladophlebis denticulata* (vide Pl. XX. Fig. 3*b*). Raciborski has suggested the probability of *Cladophlebis denticulata*[7] and some other species of the genus being

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[1] Fontaine (89), pl. v. figs. 1–6.

[2] Loc. cit. p. 71.

[3] Yokoyama (89), pl. xiv. fig. 1.

[4] Some specimens recently sent to me for identification from South Africa, by Mr. Rogers, of the Geological Commission, Cape Town, appear to be identical with *Cladophlebis denticulata*.

[5] Hooker (61), pl. iii.

[6] Christ (97), p. 273

[7] Raciborski (91), p. 2.

the sterile fronds of Osmundaceous ferns; the form of the fertile pinnæ does not favour this view, and it is more in accordance with the available evidence to refer Brongniart's species to the Polypodiaceæ. *Cladophlebis denticulata* is represented in several museums by many large and well-preserved specimens; some of the finest are to be found in the collections at Whitby and Scarborough, not infrequently labelled by Bean *Pecopteris scarburgensis.*

13,495. Pl. XIV. Fig. 3.

A part of the specimen is shown in the figure. The rachis measures 7·5 cm. in length and 4 mm. in breadth; the longest pinna is 12·5 cm. long, bearing falcated dentate segments agreeing exactly with those of the specimens figured by Brongniart as the type of the species. The pinnules are about 1·3 cm. in length. A precisely similar form is figured by Lindley & Hutton as *Neuropteris ligata.*

Gristhorpe Bay. *Presented by Dr. Murray.*

40,518. Pl. XIV. Fig. 4.

Two pinnules, represented about twice natural size, showing the fine teeth and the *Cladophlebis* type of venation. This specimen agrees with **13,495** (Pl. XIV. Fig. 3), but on the lower pinnæ the ultimate segments are longer, reaching a length of 2·2 cm.; they serve to connect the fronds with pinnules of intermediate length with such examples as that shown in Fig. 1 (**39,236**), in which the ultimate segments are longer. Towards the apex of the pinnæ the pinnules assume a shorter and more strongly falcate form.

Scarborough. *Bowerbank Coll.*

39,236. Pl. XIV. Fig. 1.

A portion only of this fine specimen is shown in the drawing. The frond has a stout rachis from which the pinnæ are given off at an acute angle, bearing falcate pinnules reaching a length of 2·8–3 cm. This type of frond is identical with that figured by Lindley & Hutton as *Pecopteris insignis*; the margin of the segments is finely dentate, as in the type-specimen of *P. insignis.*

Oolitic Shale, Scarborough. *Bean Coll.*

39,249. Pl. XX. Fig. 4.

This somewhat imperfect specimen is labelled by Bean *Pecopteris Phillipsii*, and it is partly on the evidence which it affords that

I have included this species as a synonym of *Cladophlebis denticulata.* The preservation is far from perfect, but here and there fine denticulations may be detected. The pinnules are rather less falcate and narrower than in most of the specimens, but I feel no doubt as to their specific identity, and am disposed to attribute the slight peculiarities in the appearance of this frond to the probability of its having been dried in the sun and more or less shrivelled before fossilization. Cf. the fertile pinnæ figured by Lindley & Hutton as *Phlebopteris undans.*

Scarborough. *Bean Coll.*

13,488. Pl. XX. Figs. 3*a* and 3*b*.

Fig. 3*b* represents part of a pinna of the form known as *Phlebopteris* or *Pecopteris undans.* These fertile pinnules have the same general form as the sterile segments, but are straighter and the margin is distinctly serrate; the surface of the lamina is raised in the form of oblique ridges or corrugations, parallel to the secondary veins, which are no doubt caused by the occurrence of oblong sori on the lower face. It is unfortunately impossible to obtain any more precise information as to the structure of the sori and sporangia. Cf. Schenk's figures [1] of *Asplenites ottonis* and Heer's [2] figures of *Asplenium whitbiense*; also Feistmantel's [3] figures of *Asplenites macrocarpus.*

The sterile fragment (Fig. 3*a*) shows the usual type of falcate and finely denticulate segments; I have no doubt that both these fragments (3*a* and 3*b*) belong to the same plant.

Upper Shale, Gristhorpe. *Presented by Dr. Murray.*

39,240. Pl. XV. Fig. 5.

A small piece of a pinna of a large and well-preserved frond, agreeing exactly with the specimen figured by Lindley & Hutton as *Pecopteris whitbiensis.* The margins of the pinnules appear to be entire, but in other respects the segments are exactly like those of **40,518** (Pl. XIV. Fig. 4) and **39,236** (Pl. XIV. Fig. 1). Labelled by Bean *Pecopteris whitbiensis.*

Oolitic Shale, Scarborough. *Bean Coll.*

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[1] Schenk (67), pl. xi. fig. 1.
[2] Heer (77^2), ii. pl. xxi. figs. 3 and 4.
[3] Feistmantel (77^1), pls. i., xlviii., etc.

39,245. This specimen, an imperfectly preserved portion of a fertile frond, is of interest from the point of view of the comparison of sterile and fertile pinnæ. The pinnæ and pinnules are exactly like those represented in Pl. XX. Fig. 3*a*, but in **39,245** we have a portion of the rachis as well as pieces of three or four pinnæ attached to it. Labelled by Bean *Phlebopteris undans*. The specimen shows clearly that the leaf bearing the fertile pinnæ had the same habit as the sterile fronds.

Upper Shale, Scarborough.

V. 3650, V. 3651. The latter specimen is labelled by Bean *Pecopteris scarburgensis*, a name which does not appear to have been published. Similar to **39,236** (Pl. XIV. Fig. 1).

Upper Shale, Scarborough.

V. 3940. A small piece of a pinna with long pinnules of the '*insignis*' type; labelled *Cycadites gramineus*.

Lower Shale and Sandstone, Scarborough.

39,238. A fairly large specimen, with a rachis 17 cm. in length. The habit of the frond is distinctly open, especially towards the apical portion, where the pinnæ are farther apart and the pinnules shorter and relatively broader. In the Leckenby Collection there is a still finer example, illustrating the open habit at the apex of a frond; we have precisely the same appearance presented by a specimen of *Asplenites Roesserti* figured by Schenk.[1] The pinnules are slightly dentate. Labelled by Bean *Pecopteris denticulata* and *P. ligata*.

Scarborough. *Bean Coll.*

39,248. Pl. XV. Fig. 4.

The apical portion only is shown in the drawing. It is difficult to feel certain as to the affinity of this specimen; it appears to be identical with a similar apex of a frond figured by Heer from the Jurassic rocks of Siberia as *Asplenium petruschinense*,[2] and may be compared also with *Asplenium whitbiense tenue*[3] of the same author.

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[1] Schenk (67), pl. x.

[2] Heer (78), ii. pl. i.

[3] Heer (77[2]), ii. pl. iii. fig. 5.

The slender rachis gives off opposite and sub-opposite pinnæ with short, broad, and apparently entire segments. It is not improbable that this example may be regarded as the apex of *C. denticulata*. The veins are exceedingly well shown. Cf. specimen **39,240** (Pl. XV. Fig. 5).

It is just possible that this specimen and **39,240** (Pl. XV. Fig. 5), both of which have pinnules with entire margins, belong to a separate species of the type represented by *P. whitbiensis*, as figured by Lindley & Hutton; but we have not, I think, sufficient evidence to justify a specific separation of these two specimens from *Cladophlebis denticulata*.

Oolitic Shale, Scarborough. *Bean Coll.*

Other specimens: — **V. 376.** Fragment of the apical portion of a frond similar to **39,248** (Pl. XV. Fig. 4), but rather less; too small to be determined. **V. 3900.** A small indeterminable fragment—possibly *Cladophlebis*, sp.—in white sandstone, two miles south of Ravenscar, on the Yorkshire coast. The following are undoubted examples of *C. denticulata*: **10,368, 39,235, 39,277, 40,517** (a very fine pinna with long falcate pinnules 3·7 cm. long), **40,559, 52,568** (fertile pinna).

B. *Ferns which afford no trustworthy evidence as to their affinities with existing families.*

2. Cladophlebis lobifolia (Phillips).

[Geol. Yorks. p. 148, pl. viii. fig. 13, 1829.]

(Pl. XV. Fig. 6; Text-figs. 20–23.)

1829. *Pecopteris lobifolia*, Phillips, Geol. Yorks. p. 148, pl. viii. fig. 13.
1833. *Neuropteris undulata*, Lindley & Hutton, Foss. Flor. pl. lxxxiii.
1836. *Neuropteris lobifolia*, Göppert, Foss. Farrn. p. 206.
Cheilanthes undulatus, Göppert, ibid. p. 248.
1837. *Pecopteris lobifolia*, Lindley & Hutton, Foss. Flor. vol. iii. pl. clxxix.
1838. *Pecopteris lobifolia*, Sternberg, Flor. Vorwelt, fasc. vii. p. 155.
Neuropteris undulata, ibid. p. 137.
1848. *Neuropteris lobifolia*, Bronn, Ind. Pal. p. 811.
Sphenopteris undulata, ibid. p. 1171.
1849. *Cladophlebis lobifolia*, Brongniart, Tableau, p. 105.
C. undulata, ibid.

1850. *Neuropteris lobifolia*, Unger, Gen. spec. foss. p. 86.
1854. *Pecopteris lobifolia*, Morris, Brit. Foss. p. 16.
1856. *Pecopteris lobifolia*, Zigno, Flor. foss. Oolit. vol. i. p. 131.
Neuropteris undulata, ibid. p. 124.
1864. *Neuropteris lobifolia*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
N. undulata, ibid.
1869. *Alethopteris lobifolia*, Schimper, Trait. pal. vég. vol. i. p. 567.
Sphenopteris undulata, ibid. p. 376.
1874. *Cladophlebis undulata*, Schimper, loc. cit. vol. iii. p. 505.
C. lobifolia, ibid.
1875. *Pecopteris lobifolia*, Phillips, Geol. Yorks. p. 210, pl. viii. fig. 13.
P. undulata, ibid. p. 211.
1877. ? *Alethopteris lobifolia*, Feistmantel, Pal. Ind. (77³), pl. iii. fig. 1.
1892. *Alethopteris lobifolia*, Bartholin, Bot. Tid. Bot. pl. viii. figs. 1 and 2.
Pecopteris lobifolia, Fox-Strangways, Tab. Foss. p. 133.
P. undulata, ibid.
1894. *Dicksonia lobifolia*, Raciborski, Flor. Krak. p. 177, pl. xi. figs. 1–7; pl. xii. figs. 1–6.

Frond bipinnate. Pinnæ long, linear acuminate, and spreading, given off from the rachis approximately at right angles. Pinnules linear, attached by a portion of the base, apices more or less acute, the margin usually slightly lobed; the basal pinnule on the lower side of each pinna is characterized by its greater breadth. [None of the specimens in the Museum Collection afford any evidence as to the character of the sori, but a small piece of a pinna in the Stockholm Museum (Text-fig. 23) bears indications of marginal sori; the data, however, are insufficient to enable us to determine the probable position of the species.]

Some large and well-preserved examples of *Cladophlebis lobifolia* have been figured by Raciborski [1] from the Jurassic rocks of Cracow. Among the specimens in the British Museum referred to this species there is a great difference in the size of the pinnules, but this is, I believe, largely due to the unusual length of the pinnæ, which are characterized by a gradual decrease in the length of the ultimate segments towards the distal end. Some of the larger pinnæ bear a resemblance to *Todites Williamsoni*, and a separation of the two types is not always easy; *Cladophlebis lobifolia* is usually recognizable by the narrow bases of the pinnules, and by the spreading and open habit of the frond.

[1] Raciborski (94), pls. xi. and xii.

A species of *Asplenium*, *A. Wardii*, figured by Hooker, may be quoted as a recent fern bearing a resemblance to *Cladophlebis lobifolia*.

There are unusually large specimens of *Cladophlebis lobifolia* in the York Museum.

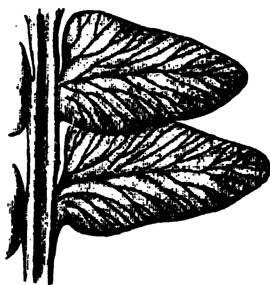


Fig. 20.—*Cladophlebis lobifolia* (Phill.). No. 10,377. (Enlarged.)

10,377. Text-fig. 20.

Portions of pinnæ with large and clearly preserved pinnules about 1·1 cm. in length. The pinnules are closely set on the pinnæ and attached by a narrow base; the apices are acute, and the whole pinnule directed slightly forwards. The veins are clearly preserved, as shown in the enlarged drawing (Fig. 20). In one of the pinnæ the pinnules decrease in size towards the distal end, where the smaller segments have a length of ·5 cm.

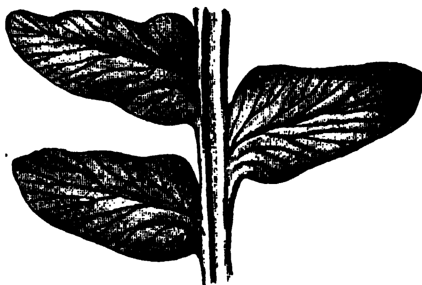


Fig. 21.—*Cladophlebis lobifolia* (Phill.). No. 39,257. (Enlarged.)

39,257. Text-fig. 21.

Fragments of three pinnæ similar to **10,377**, but the pinnules are farther apart and the margins more distinctly lobed. The form

of these larger pinnules resembles that of some of the longer fertile segments of *Todites Williamsoni.*

39,230. Text-fig. 22.

A large specimen, but not very clearly preserved. The figured portion is from the apical region of a pinna, and illustrates the gradual decrease in size of the pinnules towards the apex of one of the long pinnæ. The specimen shows clearly the characteristic open habit of the frond; long and narrow pinnæ, 13 cm. long, are attached at right angles to a slender rachis; the pinnæ have an average breadth of about 1 cm., and bear fairly closely set pinnules of the form shown in Fig. 21 (**39,257**). Those pinnæ in which the preservation is best, show the broad basal pinnule on the lower



Fig. 22.—*Cladophlebis lobifolia* (Phill.). No. 39,230.

side of the pinna where it is attached to the rachis. Cf. this specimen with the figures of Lindley & Hutton (pl. clxxix.) and Raciborski (pl. xi. fig. 1). The form of the pinnæ and pinnules is in close agreement also with that of *Neuropteris undulata*, L. & H. (pl. lxxxiii.).

Oolitic Shale, Gristhorpe Bay. *Bean Coll.*

V. 3653. Pl. XV. Fig. 6.

A similar specimen to **39,230** (Fig. 22) and to the type of Lindley & Hutton. The portion of the specimen represented in the figure illustrates the long, narrow, and spreading pinnæ, and the elongated deltoid form of the pinnules. The lower pinna in Fig. 6, Pl. XV. shows the large basal pinnule immediately below the point of attachment of the pinna to the rachis.

Gristhorpe Bay.

Text-fig. 23. (Stockholm Museum of Palæobotany.)

This specimen, for which I am indebted to the kindness of Professor Nathorst, who also sent me an accurate sketch of the portion shown in the figure, illustrates the manner of occurrence of the sori. The sporangia cannot be made out with any degree of clearness, but they appear to have been borne in semicircular pocket-like depressions on the edges of the fertile segments. Cf. **V. 3653** (Pl. XV. Fig. 6).



Fig. 23.—*Cladophlebis lobifolia* (Phill.). From a specimen and drawing kindly lent by Professor Nathorst.

V. 3657. Part of a large pinna with pinnules ranging in length from 1·5 to ·7 cm.; the individual segments agree precisely with those of Fig. 6, Pl. XV.

V. 3938. Small pieces of two pinnæ with pinnules ·7 cm. long, intermediate between the segments of such a specimen as that of Fig. 6, Pl. XV. and the large forms like **V. 2519, 39,257** (Text-fig. 21), etc. Cf. '*Neuropteris undulata*,' L. & H., pl. lxxxiii.

V. 3939. An imperfectly preserved specimen, with pinnules of median length; the three lowest pinnæ show the large basal segments.

Upper Shale, Gristhorpe Bay.

Other specimens:—**V. 2519, V. 3659, V. 3933, 13,489, 39,229, 39,258.**

3. Cladophlebis haiburnensis (Lindley & Hutton).

[Foss. Flor. vol. iii. pl. clxxxvii. 1836.]

1836. *Pecopteris haiburnensis*, Lindley & Hutton, Foss. Flor. pl. clxxxvii.
1838. *Pecopteris haiburnensis*, Sternberg, Flor. Vorwelt, fasc. vii. p. 154.
1848. *Pecopteris haiburnensis*, Bronn, Ind. Pal. p. 916.
1849. *Cladophlebis haiburnensis*, Brongniart, Tableau, p. 105.
1850. *Pecopteris haiburnensis*, Unger, Gen. spec. plant. foss. p. 179.
1854. *Pecopteris haiburnensis*, Morris, Brit. Foss. p. 15.
1856. *Pecopteris haiburnensis*, Zigno, Flor. foss. Oolit. vol. i. p. 137.
1864. *Pecopteris haiburnensis*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
1869. *Alethopteris haiburnensis*, Schimper, Trait. pal. vég. vol. i. p. 565.
1875. *Pecopteris haiburnensis*, Phillips, Geol. Yorks. p. 211, lign. 25.
1892. *Pecopteris haiburnensis*, Fox-Strangways, Tab. Foss. p. 133.
1894. *Thinnfeldia haiburnensis*, Raciborski, Flor. Krak. pl. xx. figs. 3–6.

Type-specimen. Newcastle-upon-Tyne Museum.[1] The available material is insufficient to enable us to give a satisfactory diagnosis of the species. The frond was probably bipinnate; the large, broadly linear pinnules have the *Cladophlebis* type of venation; they are attached at almost a right angle, and differ from those of *C. denticulata* in being straighter and not falcate. There are no specimens in the British Museum Collection which can be reasonably referred to this species. A solitary example in the Leckenby Collection, Cambridge (No. 80), agrees exactly with the specimen figured by Lindley & Hutton. It is possible that *Cladophlebis haiburnensis* is not a distinct species, but the general appearance of the Leckenby specimen hardly favours its inclusion in any of the other species of *Cladophlebis* or in *Todites Williamsoni*. There is a striking similarity between *C. haiburnensis* and a specimen named by Heer *Asplenium whitbiense tenue*.[2]

[1] Lebour (78), p. 115.
[2] Heer (77), ii. pl. iii. fig. 5.

Genus SPHENOPTERIS, Brongniart.[1]

[Mém. Mus. Hist. nat. Paris, vol. viii. p. 233, 1822.]

1. **Sphenopteris princeps**, Presl.
2. **Sphenopteris Williamsoni**, Brongniart.
3. **Sphenopteris Murrayana** (Brongniart).

1. Sphenopteris princeps, Presl.

[Sternberg, Flor. Vorwelt, vii. p. 126, pl. lix. figs. 12 and 13, 1838.]

(Pl. XVI. Fig. 2.)

1838. *Sphenopteris princeps*, Sternberg, Flor. Vorwelt, vii. p. 126, pl. lix. figs. 12 and 13.
Germaria elymiformis, ibid. p. 188, pl. lix. figs. 1–9.
Pecopteris obtusa, ibid. p. 155, pl. xxxii. figs. 2*a*–*c* and 4*a*, *b*.
1841. *Sphenopteris patentissima*, Göppert, Gatt. foss. Pflan. p. 73, pl. x. fig. 8.
1849. *Coniopteris princeps*, Brongniart, Tableau, p. 103.
C. patentissima, ibid.
Desmophlebis imbricata, ibid.
D. obtusa, ibid.
1856. *Sphenopteris modesta*, Zigno, Flor. foss. Oolit. vol. i. p. 85.
1864. *Sphenopteris modesta*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 79, pl. x. figs. 3*a* and 3*b*.
1874. *Cladophlebis modesta*, Schimper, Trait. pal. vég. vol. iii. p. 505.
1875. *Sphenopteris modesta*, Phillips, Geol Yorks. p. 213, lign. 28.
1892. *Acrostichites princeps*, Fox-Strangways, Tab. Foss. p. 128.
1894. *Todea princeps*, Raciborski, Flor. Krak. p. 18, pl. vi. figs. 22–27.

Type-specimen. Leckenby's type-specimen of *Sphenopteris modesta* is in the Leckenby Collection, Cambridge (No. 149).

Fronds bipinnate, attached to an erect stem covered with imbricate pointed scales; pinnæ linear, tapering to a point, attached at right angles to a comparatively slender rachis, and bearing crowded pinnules with an obtuse apex and an irregularly crenulate margin. The pinnules are at right angles to the pinnæ and present a characteristic and somewhat stiff appearance; the

[1] For an account of this genus vide Seward (94[1]), p. 104.

venation might be described almost equally well as agreeing with the *Sphenopteris* or *Cladophlebis* type; in the larger pinnules there is a definite midrib giving off forked secondary veins at an acute angle, but in the smaller deltoid segments the venation is more spreading and approximates more closely to that of *Sphenopteris*. The fertile segments bear sporangia covering the lower surface. The rectangular disposition of the pinnæ and pinnules and the rather indefinite ragged appearance of the delicate and finely crenulate segments give to this species a characteristic habit.

The description of the stem and of the fertile segments is taken from Schenk's diagnosis[1] of *Acrostichites princeps*; neither stems nor fertile segments have so far been recognized in association with the English specimens.

In his valuable notes on the English Jurassic plants, Nathorst[2] has expressed the opinion that the specimens for which Leckenby instituted the new specific name *Sphenopteris modesta* are identical with Presl's Rhætic species *S. princeps*, afterwards referred by Schenk to the genus *Acrostichites* and fully described and illustrated in the *Flora of the Rhætic Beds of Franconia*. The figures given by Schenk represent a type of frond which appears to be identical with Leckenby's *Sphenopteris modesta*. I cannot detect any discrepancies which justify a specific separation of the two sets of specimens; in spite of the fact that one plant is from Rhætic and the other from Lower Oolitic rocks, Nathorst's determination has therefore been adopted.

Nathorst points out that the generic name *Acrostichites*, chosen by Schenk on the strength of the fertile pinnule having the under surface covered with sporangia, is not very suitable, as the same manner of occurrence of sporangia is met with also in species of *Aspidium* and other recent genera. We may add that the same mode of occurrence of crowded sporangia occurs also in *Todea*, as illustrated by the Jurassic species formerly referred to *Acrostichites* and now placed in the genus *Todites*. Raciborski[3] records *Sphenopteris princeps* from Cracow, and places it in the Osmundaceæ under the name *Todea princeps*.

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[1] Schenk (67), p. 46.
[2] Nathorst (80[1]), p. 56.
[3] Raciborski (91), p. 4.

Some of the species mentioned in the above synonymy have been included on the evidence furnished by Schenk as the result of his examination of the actual specimens.

As there is no indication of sporangia on any of the specimens of this species in the English collections, I have adopted what may appear to be a somewhat retrograde course in placing *Sphenopteris princeps* among ferns which cannot safely be assigned to a definite family. The evidence published by Continental authors does not seem to be sufficiently convincing to warrant the inclusion of the Yorkshire plant in the family Osmundaceæ.

41,397. Pl. XVI. Fig. 2.

This specimen, of which a part is shown in the drawing, agrees very closely with Leckenby's type-specimen of *Sphenopteris modesta*, now in the Leckenby Collection. Compare also Schenk's[1] pl. viii. fig. 1 with Pl. XVI. Fig. 2 of this Catalogue; the two figures present a very close resemblance, and one can hardly doubt that they represent leaves specifically identical.

The pinnæ are at right angles to the rachis, and the crowded pinnules at right angles to the axis of each pinna. There are some fragments with smaller pinnules on the same piece of shale, which agree with the smaller pinnæ figured by Schenk.

Upper Shale, Scarborough. *Presented by J. Leckenby, Esq.*

41,397A. The upper portion of a frond, showing that even the smaller apical pinnæ are at right angles to the rachis.

Scarborough. *Presented by J. Leckenby, Esq.*

41,397B. A fine specimen showing portions of several fronds, which are arranged on the shale as though converging towards a common stem; a similar disposition is shown more clearly in some of Schenk's figures of the Rhætic plant (pl. viii. fig. 1). The smaller segments in this and other specimens are more or less deltoid in shape, with spreading, acutely forked veins.

Scarborough. *Presented by J. Leckenby, Esq.*

Other specimens:—**V. 3304, V. 3931, 39,259.**

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[1] Schenk (67).

2. Sphenopteris Williamsoni, Brongniart.

[Hist. vég. foss. p. 177, pl. xlix. figs. 6–8, 1828.]

(Pl. XVII. Figs. 1 and 2.)

1828. *Sphenopteris Williamsonis*, Brongniart, Hist. vég. foss. p. 177, pl. xlix. figs. 6–8.
? *S. denticulata*, ibid. pl. lvi. fig. 1.
S. Williamsonis, Brongniart, Prodrome, p. 50.
1829. *Sphenopteris digitata*, Phillips, Geol. Yorks. p. 147, pl. viii. fig. 6.
1834. *Sphenopteris Williamsonis*, Lindley & Hutton, Foss. Flor. pl. cxxxi.
1836. *Hymenophyllites Williamsonis*, Göppert, Foss. Farrn. p. 259.
1838. *Rhodea Williamsonis*, Sternberg, Flor. Vorwelt, fasc. vii. p. 110.
1848. *Hymenophyllites Williamsonis*, Bronn, Ind. Pal. p. 602.
1849. *Sphenopteris Williamsonis*, Brongniart, Tableau, p. 105.
1850. *Hymenophyllites Williamsonis*, Unger, Gen. spec. foss. p. 130.
1854. *Hymenophyllites Williamsonis*, Morris, Brit. Foss. p. 10.
1856. *Hymenophyllites Williamsonis*, Zigno, Flor. foss. Oolit. vol. i. p. 89.
1864. *Hymenophyllites Williamsonis*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1869. *Sphenopteris* (*Hymenophyllites*) *Williamsonis*, Schimper, Trait. pal. vég. vol. i. p. 410.
1875. *Sphenopteris Williamsonis*, Phillips, Geol. Yorks. p. 217, pl. viii. fig. 6.
1892. *Sphenopteris Williamsonis*, Fox-Strangways, Tab. Foss. p. 135.

Type-specimen. Brongniart's types in the Paris Museum (?). Type of Lindley & Hutton in the Scarborough Museum.

Frond ? tripinnate; the rachis slender and winged, bearing short acuminate pinnæ attached at an acute angle; the pinnules are deeply dissected into narrow linear and forked ultimate segments.

There is not sufficient reason for following the example of some authors and using the generic name *Hymenophyllites* for this species; we know nothing as to the character of the sori or sporangia.

39,281. Pl. XVII. Fig. 2.

The drawing represents a portion of a pinna 7 cm. long, bearing deeply dissected pinnules with narrow ultimate segments. The finer segments are traversed by a single vein, and the general appearance of the specimen suggests a fern with a thin or almost filmy texture; this thin brown filmy appearance is misleading and need not necessarily point to an originally thin lamina. There is

a fairly close resemblance between this example and Brongniart's figure[1] of a specimen of *Sphenopteris denticulata* from the Yorkshire coast.

The pinnules of this fragment are smaller and rather more delicate than those in **8250** (Pl. XVII. Fig. 1). Labelled by Bean *S. Williamsonis*.

Gristhorpe Bay. *Bean Coll.*

8250. Pl. XVII. Fig. 1.

A smaller piece than **39,281**, but the ultimate segments are much longer; it agrees exactly with the figures of this species given by Brongniart and by Lindley & Hutton.

Part of a frond of *Todites Williamsoni* on the same piece of shale. Scarborough.

13,499. Fragments similar to **8250**, but very imperfect. Compare this specimen with Phillips' figure of this species and Williamson's drawing in the *Fossil Flora* of Lindley & Hutton.

Gristhorpe Bay. *Presented by Dr. Murray.*

3. Sphenopteris Murrayana (Brongniart).

[Hist. vég. foss. p. 358, pl. cxxvi. figs. 1, 2, and 4, 1828.]

(Pl. XXI. Fig. 5.)

1828. *Pecopteris Murrayana*, Brongniart, Hist. vég. foss. p. 358, pl. cxxvi. figs. 1, 2, and 4.

1829. ? *Sphenopteris arbuscula*, Phillips, Geol. Yorks. lign. 36, p. 216.

Type-specimen. ? Natural History Museum, Paris.

Frond tripinnate; pinnæ broad and spreading, given off from the rachis almost at right angles; ultimate segments crowded, deltoid in form, and similar to those of *Coniopteris hymenophylloides* (Brongn.).

It has been pointed out in discussing *Coniopteris hymenophylloides*, that in all probability some of the specimens included by Brongniart and others under the name *Pecopteris* or *Sphenopteris Murrayana* may belong to a distinct species, which we have referred to

[1] Brongniart (28[2]), pl. lvi. fig. 1.

C. hymenophylloides; but other specimens exhibit certain differences which seem to point to the retention of *Sphenopteris Murrayana* for certain fern fronds agreeing with the examples figured by Brongniart in figs 1, 2, and 4 of his pl. cxxvi.[1] Possibly this separation may prove to be artificial, but it is at least a convenience to distinguish some of the Yorkshire ferns, which differ in a few points from the typical *Coniopteris hymenophylloides*, by a distinct specific designation. It is hopeless to attempt a complete synonymy of *Sphenopteris Murrayana* as employed in the present sense, as the greater number of the fossils so named by various authors should be referred rather to *C. hymenophylloides*. As no specimen exhibiting the vegetative characters which we associate with *S. Murrayana* in its restricted sense has been seen with fertile pinnules, the genus *Sphenopteris* is retained in preference to *Pecopteris* or *Coniopteris*.

The fronds of the *S. Murrayana* type appear to be characterized by a spreading habit, and by the broad pinnæ being almost at right angles to the rachis.

39,273. Pl. XXI. Fig. 5.

The fragment illustrated consists of a secondary rachis bearing short pinnæ with small pinnules having the *Sphenopteris* type of venation, and agreeing fairly closely in form with those of *Coniopteris hymenophylloides*. It is, however, quite possible that such specimens as this may belong to the lower portions of large *Coniopteris* fronds. Labelled by Bean *Sphenopteris arguta*.

Upper Shale, Scarborough. *Bean Coll.*

V. 3679. A large but imperfectly preserved frond, bearing pinnæ like that represented in Fig. 5. Labelled by Bean *Pecopteris Murrayana*.

Lower Shale and Sandstone, Scarborough. *Bean Coll.*

V. 3287. Probably specifically identical with the above.

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[1] Brongniart (28[2]).

Genus TÆNIOPTERIS, Brongniart.[1]

[Prodrome, p. 61, 1828.]

1. **Tæniopteris vittata**, Brongniart.
2. **Tæniopteris major**, Lindley & Hutton.

1. Tæniopteris vittata, Brongniart.

[Hist. vég. foss. p. 263, pl. lxxxii. figs. 1–4, 1828.]

(Pl. XVI. Fig. 1.)

1823. *Scitaminearum folium*, Sternberg, Flor. Vorwelt, iii. p. 42, pl. xxxvii. fig. 2.
1828. *Tæniopteris vittata*, Brongniart, Prodrome, p. 62.
T. vittata, Brongniart, Hist. vég. foss. p. 263, pl. lxxxii. figs. 1–4.
1829. *Scolopendrium solitarium*, Phillips, Geol. Yorks. p. 147, pl. viii. fig. 5.
1833. *Tæniopteris vittata*, Lindley & Hutton, Foss. Flor. pl. lxii.
1835. Cf. *Tæniopteris vittata*, ibid. pl. clxxvi. B.
1836. *Aspidites tæniopteris*, Göppert, Foss. Farrn. p. 350.
1838. *Tæniopteris vittata*, Sternberg, Flor. Vorwelt, fasc. vii. p. 139.
1848. *Tæniopteris vittata*, Bronn, Ind. Pal. p. 1215.
1849. *Tæniopteris vittata*, Brongniart, Tableau, p. 105.
1850. *Tæniopteris vittata*, Unger, Gen. spec. foss. p. 213.
1854. *Tæniopteris vittata*, Morris, Brit. Foss. p. 23.
1856. *Tæniopteris vittata*, Zigno, Flor. foss. Oolit. vol. i. p. 201.
1863. ? *Stangerites spatulata*, Oldham & Morris, Pal. Ind. pl. vi.
1864. *Tæniopteris vittata*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1868. *Tæniopteris vittata*, Eichwald, Leth. Ross. pl. ii. fig. 5.
1869. *Oleandridium vittatum*, Schimper, Trait. pal. vég. vol. i. p. 607.
1872. Cf. *Tæniopteris Daintreei*, Carruthers, Quart. Journ. Geol. Soc. vol. xxviii. pl. xxvii. fig. 6.
1873. *Tæniopteris vittata*, Saporta, Pal. Franç. vol. i. p. 444, pl. lxiv. figs. 1–5.
1875. *Tæniopteris vittata*, Phillips, Geol. Yorks. p. 205, pl. viii. fig. 5.
1876. *Oleandridium vittatum*, Feistmantel, Pal. Ind. pl. i. fig. 2.
Cf. *Tæniopteris mareyesiaca*, Geinitz, Geol. Pal. Argent. Repub. (Palæontographica), pl. ii. figs. 1–3.
1887. Cf. *Oleandridium tenuinerve*, Schenk, Foss. Pflanz. Alburskette, pl. v. fig. 20.

[1] Vide Seward (94[1]), p. 122.

1890. *Oleandridium vittatum*, Schimper, in Zittel's Handbuch, p. 133, fig. 107.
1892. *Tæniopteris vittata*, Fox-Strangways, Tab. Foss. p. 136.
1894. Cf. *Tæniopteris vittata*, Raciborski, Flor. Krak. pl. xx. figs. 9 and 10.
1897. ? *Oleandridium vittatum*, Bartholin, Danmarks Geol. Anders. fig. 8.

Type-specimen. ? Natural History Museum, Paris.

Frond simple, linear-lanceolate, reaching a length of more than 20 cm. and a breadth of 3 cm. The lamina increases gradually in breadth from the petiole and tapers gradually towards the apex. Numerous secondary veins are given off at right angles from a broad midrib; these are simple or forked; the branching of the lateral veins may take place close to the midrib, in the marginal or in the intermediate portion of the lamina.

There is a close agreement between the English specimens of *Tæniopteris vittata* and the species *T. tenuinervis*, Brauns, as figured by Schenk[1] and other authors, but in dealing with leaves of the *Tæniopteris* type it is practically hopeless to attempt to distinguish between closely allied and identical forms.

Unless its sori or sporangia are preserved, it is impossible to determine the family of ferns to which *Tæniopteris* leaves should be referred; this simple type of leaf is met with in several recent genera, and is of little or no value as an indication of affinity. *Tæniopteris vittata* is one of the commonest fossils from the Yorkshire coast rocks.

39,217. Pl. XVI. Fig. 1.

The lower part only of the specimen is shown in the figure. The lamina is 20 cm. long, and the slightly curved petiole 2·5 cm.; the latter appears to terminate in a fairly clean-cut face, which is probably the actual base by which the leaf was attached to a rhizome. This feature suggests a comparison with the leaves of the recent fern *Oleandra neriiformis*, Cav., which become cut off near the base of the petiole by a well-marked absciss-layer. The lamina in its broadest part measures 3 cm.; the lateral veins are seen to fork at varying distances from their point of origin from the broad midrib.

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[1] Schenk (67), p. 101, pl. xxv. Vide also Bartholin (92), pl. ix. fig. 7.

Pieces of *Nilssonia compta* and *Cladophlebis denticulata* occur on the same piece of rock.

Scarborough. *Bean Coll.*

V. 3670. A good example of a smaller frond. At the base there is a short curved petiole similar to that of **39,217**, but shorter, and the frond tapers gradually to an acuminate apex. The venation is well preserved.

Gristhorpe Bay.

8366. Lamina 15·5 cm. long, without the apex, 1·8 cm. broad. The breadth is fairly uniform, decreasing gradually towards the base and apex.

Scarborough. *Mantell Coll.*

10,327. Fragments showing clear venation; associated with *Sagenopteris Phillipsi*, *Cladophlebis lobifolia*, *Beania*, etc.

Gristhorpe Bay. *Presented by Dr. Murray.*

13,501. An impression in ironstone of part of a large frond, showing very clearly the forking of the secondary veins. Midway between the broad midrib and the edge of the lamina there are about seven veins to every 5 cm. of lamina; close to the margin the veins become much more numerous.

Gristhorpe Bay. *Presented by Dr. Murray.*

13,502*a*. A long and narrow frond similar to **V. 3670.**

Gristhorpe Bay. *Presented by Dr. Murray.*

Other specimens:—**V. 3294, 39,310.**

2. Tæniopteris major, Lindley & Hutton.

[Foss. Flor. vol. ii. pl. xcii. 1833.]

1833. *Tæniopteris major*, Lindley & Hutton, Foss. Flor. pl. xcii.
1836. *Aspidites Williamsonis*, Göppert, Foss. Farrn. p. 353.
1838. *Tæniopteris major*, Sternberg, Flor. Vorwelt, fasc. vii. p. 140.
1848. *Tæniopteris major*, Bronn, Ind. Pal. p. 1214.
1850. *Tæniopteris major*, Unger, Gen. spec. foss. p. 212.
1854. *Tæniopteris major*, Morris, Brit. Foss. p. 23.
1856. *Tæniopteris Williamsonis*, Zigno, Flor. foss. Oolit. vol. i. p. 205.
1863. ? *Tæniopteris ovalis*, Oldham & Morris, Pal. Ind. pl. iii. figs. 3–6.
Cf. *Tæniopteris lata*, ibid. pls. i.–iii.

1864. *Tæniopteris major*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 78.
1869. *Macrotæniopteris major*, Schimper, Trait. pal. vég. vol. i. p. 610.
1875. *Tæniopteris major*, Phillips, Geol. Yorks. p. 204, lign. 15.
1877. *Macrotæniopteris ovata*, Feistmantel, Pal. Ind. (77[1]), pl. xxxvii.
1892. *Tæniopteris major*, Fox-Strangways, Tab. Foss. p. 136.
1900. *Tæniopteris major*, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 14.

Type-specimen. Manchester Museum.[1]

Frond simple, similar in venation to *T. vittata*, but of greater breadth in proportion to its length than the previous species. The midrib in *T. major* is narrower and less prominent than in *T. vittata*. Veins approximately at right angles to the midrib, rather farther apart than in *T. vittata*, forked either close to the midrib or at varying distances from their point of origin.

The specimen figured by Lindley & Hutton from a drawing by Williamson, and now in the Manchester Museum, illustrates the characteristic form of this broader-leaved *Tæniopteris* very clearly; the dichotomously branched veins are clearly shown. Some authors have called attention to the venation of this species as a distinguishing feature; in *T. vittata* the secondary veins are said to be simple or once forked, while in the broader form the veins are repeatedly forked. This supposed distinction does not hold as a satisfactory means of identification; in both the long and narrow as well as in the broader fronds we find the same manner of forking in the lateral veins. The differences indeed between *T. vittata* and *T. major* are barely sufficient to warrant a specific separation, but as the greater breadth of *T. major* appears to be a fairly constant character, as well as other small differences, it is probably better to retain both names.

Nathorst[2] has suggested that *T. major* may be an entire leaf of *Anomozamites Lindleyanus*, but this is, I think, improbable. The best specimen in the British Museum Collection is the clearly preserved portion of a leaf associated with some impressions of *Marchantites erectus* (Leck.) (No. 39,328); this form of frond, however, is not well represented.

It is not improbable that the short and broad leaf described by Lindley & Hutton as *Otopteris ovalis*[3] may be the young frond

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[1] Seward (00), p. 14. [2] Nathorst (80[1]), p. 63.
[3] Lindley & Hutton (37), pl. ccx.

of *T. major*, as Nathorst suggests;[1] but the type-specimen in the Scarborough Museum is too imperfect and indistinct to enable one to form any decided opinion as to its nature; the veins are too indefinite to be made out. It is probably wiser under these circumstances to omit this 'species,' which has been referred to by Sternberg, Morris, Zigno, and others as *Tæniopteris ovalis*, from the list of synonyms.

10,375. Two imperfectly preserved fronds with similar venation to that of *Tæniopteris vittata*, but broader in proportion to their length and with a narrower and less prominent midrib. Also fragments of *Sagenopteris Phillipsi*, etc.

Upper Sandstone, Gristhorpe. *Mantell Coll.*

39,219. A good specimen, showing a portion of the petiole.

Bean Coll.

Genus SAGENOPTERIS, Presl.

[Sternberg, Flor. Vorwelt, vii, p. 164, 1838.]

The position of the genus *Sagenopteris* in the plant kingdom is still undecided. More than one writer has placed this Mesozoic plant in the Marsiliaceæ,[2] but, as I have elsewhere pointed out,[3] the evidence on which this conclusion is based is hardly satisfactory. While admitting the absence of such characters as might enable us to speak with any degree of certainty as to systematic position, I am disposed to regard *Sagenopteris* as probably a genus of ferns. Fontaine[4] has figured some leaflets of *Sagenopteris* from the Potomac beds bearing small dot-like elevations, which may be the remains of sori or sporangia. He regards the specimens as favouring the inclusion of *Sagenopteris* among the ferns.

[1] Nathorst (80^1), p. 63.
[2] Nathorst (78^2), p. 26; Potonié (99), p. 175.
[3] Seward (94^1), p. 129.
[4] Fontaine (89), p. 149, pl. xxvii. figs. 9 and 11–17.

Sagenopteris Phillipsi (Brongniart), including the varieties **major** and **cuneata.**

[Hist. vég. foss. p. 225, pl. lxi. *bis*, fig. 5; pl. lxiii. fig. 2, 1828.]

(Pl. XVIII. Figs. 2, 3, and 4; Text-figs. 24–26.)

1828. *Glossopteris Phillipsii*, Brongniart, Hist. vég. foss. p. 225, pl. lxi. *bis*, fig. 5, pl. lxiii. fig. 2.
1829. *Pecopteris paucifolia*, Phillips, Geol. Yorks. p. 148, pl. viii. fig. 8.
1833. *Glossopteris Phillipsii*, Lindley & Hutton, Foss. Flor. pl. lxiii.
1835. *Otopteris cuneata*, ibid. pl. clv.
1836. *Acrostichites Phillipsii*, Göppert, Foss. Farrn. p. 286.
Adiantites irregularis, ibid. p. 385.
Aspidites Nilssonianus, ibid. p. 354.
1838. *Glossopteris Phillipsii*, Sternberg, Flor. Vorwelt, fasc. vii. p. 69.
Tæniopteris Phillipsii, ibid. p. 140.
Sagenopteris Phillipsii, ibid. p. 165.
Cyclopteris cuneata, ibid. p. 135.
1848. *Tæniopteris Phillipsii*, Bronn, Pal. Ind. p. 1215.
1849. *Phyllopteris Phillipsii*, Brongniart, Tableau, p. 105.
1850. *Glossopteris Phillipsii*, Unger, Gen. spec. foss. p. 528.
Acrostichites Phillipsii, ibid. p. 141.
Tæniopteris Phillipsii, ibid. p. 213.
1851. *Sagenopteris cuneata*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 184.
1854. *Sagenopteris Phillipsii*, Morris, Brit. Foss. p. 19.
1856. *Phyllopteris Phillipsii*, Zigno, Flor. foss. Oolit. vol. i. p. 166.
Sagenopteris cuneata, ibid. p. 183, pl. xx. fig. 11.
S. Phillipsii, ibid. p. 187.
1864. *Glossopteris Phillipsii*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1869. *Sagenopteris Phillipsii*, Schimper, Trait. pal. vég. vol. i. p. 642.
1875. *Glossopteris Phillipsii*, Phillips, Geol. Yorks. Coast, p. 203, pl. viii. fig. 8.
1876. Cf. *Sagenopteris Charpentieri*, Heer, Flor. foss. Helvet. pl. li. fig. 9.
1889. Cf. *Sagenopteris elliptica*, Fontaine, Potomac Flora, p. 149, pl. xxvii. figs. 9 and 11–17.
1892. *Sagenopteris Phillipsii*, Bartholin, Bot. Tids. Kjöv. p. 13, pl. v. figs. 7 and 8.
1892. *Sagenopteris* (*Glossopteris*) *Phillipsii*, Fox-Strangways, Tab. Foss. p. 128.
1894. *Sagenopteris Phillipsii*, Raciborski, Flor. Krakow. p. 214, pl. xx. figs. 19 and 20.
S. Goeppertiana, ibid. p. 214, pl. xx. figs. 14–18.
1900. *Sagenopteris Phillipsi*, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 11.

Type-specimens. Brongniart's type in the Paris Museum (?); that of *Otopteris cuneata* of Lindley & Hutton in the Manchester Museum. The specimens figured by Phillips (pl. viii. fig. 8) and by Lindley & Hutton (pl. lxiii.) are in the York and British Museums respectively.

Frond very variable, petiolate; in some forms the petiole bears four linear lanceolate leaflets having a distinct midrib and oblique anastomosing lateral veins; in other forms a shorter winged petiole bears one or two shorter and broader, somewhat obcuneate leaflets without a midrib and traversed by spreading anastomosing veins.

The figures published by Brongniart of this species represent the leaves with dichotomous but not anastomosing secondary veins; one of the drawings was communicated to him by Professor Phillips and another was drawn from a specimen supplied by Dr. Murray. At a later date Brongniart instituted a new genus *Phyllopteris* [1] to include the leaves previously identified as *Glossopteris Phillipsii*; the specimens figured by Lindley & Hutton under the latter name are referred by the French author to *Sagenopteris*. This separation of the Yorkshire fossils into two genera, *Phyllopteris* and *Sagenopteris*, was the result of incorrect representation of the venation in some of the earlier figures; there is, however, no doubt as to the identity of the plants figured by Brongniart and Lindley & Hutton.

In plate clv. of the *Fossil Flora* a smaller form of leaf with anastomosing venation is represented under the name *Otopteris cuneata*; these specimens agree as regards the anastomosing veins with the longer and narrower leaves which the authors referred to *Glossopteris Phillipsii*, but differ in the absence of a midrib and in having fewer leaflets on each frond. The original specimen of one of the drawings in plate clv. of the *Fossil Flora* is now in the Manchester Museum.[2]

In 1851 Bunbury discussed at some length the affinities of *Otopteris cuneata*, L. & H.; he considered that this species "is merely an imperfect or abnormal state—probably a seedling—of *Sagenopteris Phillipsi*." Speaking of a specimen in Mr. Bean's collection, which is in all probability No. 39,311 in the British

[1] Brongniart (49), p. 22.
[2] Refigured, Seward (00), pl. iii. figs. 7 and 8.

Museum Collection (pl. xviii. fig. 3), Bunbury draws attention to the occurrence of one "inversely heart-shaped" terminal leaflet "cleft into two lobes." "This sort of variation," he adds, "appears quite analogous to what we often see in the primordial or seedling fronds of recent ferns." In the third edition of Phillips' *Geology of the Yorkshire Coast* it is also suggested that this cuneate form may be specifically identical with the longer-leaved *Sagenopteris Phillipsi*.[1] Some leaflets from Australia figured by Feistmantel[2] as *Glossopteris spathulata-cordata* bear a close resemblance to *Sagenopteris Phillipsi*, var. *cuneata*.

Although it is impossible to decide the question of identity of *Sagenopteris Phillipsi* and *S. cuneata*, I am inclined to agree with Bunbury that it is at least reasonable to suppose that both forms of leaf were borne by the same species. Evidence of the variation in the form of the leaf displayed by this genus is furnished by numerous specimens (in the British and other Museums) of what no one would hesitate to refer to *S. Phillipsi*: the size of the leaflets varies considerably; the proportion of breadth to length and the distinctness or prominence of the midrib are characters subject to considerable variation. Again, in the series of figures of the Rhætic species *Sagenopteris rhoifolia* (Presl), and in the drawings of species of this genus published by Zigno and Nathorst, we have abundant proof of the variability displayed by the leaflets.

There is a reference in the later edition of Phillips' work and in the more recent notes on Jurassic plants by Nathorst to a larger form of *Sagenopteris* leaflet, represented in the Leckenby Collection and elsewhere, which agrees closely with *S. Goeppertiana* described by Zigno from the Italian Oolites. A leaf figured by Feistmantel[3] as *Sagenopteris*, sp., may also be compared with this larger type of *S. Phillipsi*. This form of leaflet is represented in Fig. 26, drawn from a specimen in the Scarborough Museum; a still larger example of this form in the Manchester Museum has a length of 11 cm.[4]

In spite of the striking difference between such a leaflet as that shown in Text-fig. 26 and the leaflets represented in Figs. 2–4 of

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[1] Phillips (75), p. 203.
[2] Feistmantel (90), pl. xx. figs. 5–8.
[3] Feistmantel (81[3]), pl. xlii. A.
[4] Seward (00), pl. iii. fig. 8.

Pl. XVIII. and Text-fig. 24, I believe it is the better plan to include all under one specific name, and as a matter of convenience to refer to the very small and very large forms as *Sagenopteris Phillipsi*, var. *cuneata*, and *S. Phillipsi* var. *major*, respectively. Such a method of designating by descriptive varietal names extreme types of leaves which may be connected by a fairly complete series of transitional forms, and which there is no sufficient reason for referring to as to distinct species, may in some cases prove convenient.

The English species of *Sagenopteris*, *S. Phillipsi*, differs from *S. rhoifolia* and from *S. Goeppertiana* chiefly in the longer and narrower form of the leaflets, but the larger type of leaf such as that shown in Text-fig. 26, and the intermediate forms represented by fig. 1, pl. lxiii. of Lindley & Hutton (No. 39,221 in the Museum Collection), agree very closely with Schenk's figures of *S. rhoifolia*,[1] and with those given by Zigno of *S. Goeppertiana*.[2] The specimens from Australia, figured by Feistmantel as *S. rhoifolia*,[3] are very similar to many of the forms of *S. Phillipsi*. In a letter written by Bean[4] to Lindley in 1832 accompanying the drawings afterwards published in the *Fossil Flora* (pl. lxiii.), the broader-leaved form is named *Pecopteris Dunnii*, but this designation, like many of Bean's manuscript names, was never adopted. Some of the narrower-leaved forms of *S. Phillipsi* may be compared with *S. angustifolia*, Zigno,[5] and with *S. undulata*, Nathorst.[6]

A fragment recently figured by Shirley from Queensland as *Sagenopteris cuneata*[7] is too small for accurate determination.

39,222. Text-fig. 24. Also Lindley & Hutton, *Fossil Flora*, pl. lxiii. fig. 2.

In this specimen there is a petiole 3·7 cm. long, bearing four linear lanceolate segments in which the midrib is well marked and the lateral anastomosing veins stand out very clearly. The

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[1] Schenk (67), pl. xii.

[2] Zigno (56), pl. xxi.

[3] Feistmantel (90), pl. xxviii.

[4] My thanks are due to Professor Lebour, of Newcastle, for giving me access to this letter.

[5] Zigno (56), pl. xx. fig. 1.

[6] Nathorst (78[1]), pl. xix. fig. 2.

[7] Shirley (98), pl. xxiii. p. 24.

drawing by Miss Helen Thornhill, published by Lindley & Hutton, does not convey an accurate idea of the fine and radially elongated meshes formed by the secondary veins. The tips of the segments



FIG. 24.—*Sagenopteris Phillipsi* (Brongn.). No. 39,222. (Nat. size.)

have not been preserved; the longest measures 6·5 cm. in length, and is 1 cm. broad at the broadest part.

Gristhorpe Bay. *Bean Coll.*

13,511. Pl. XVIII. Fig. 4.

This specimen agrees in essential respects with the preceding, but the four leaflets appear to have become detached from the

common petiole, and occur spread out on the shale at a wider angle from one another than in the example shown in Text-fig. 24. The right-hand leaflet shows the tapering apical portion and the characteristic curvature of the narrowed distal end.

Gristhorpe Bay. *Presented by Dr. Murray.*

39,220. Pl. XVIII. Fig. 2. *Sagenopteris Phillipsi*, var. *cuneata.*

This example, which agrees closely with those figured by Lindley & Hutton as *Otopteris cuneata*,[1] consists of a stalk 4 mm. wide, with a thick median portion and thin lateral wings, bearing two cuneiform segments. The segments have a fairly well-marked midrib, dividing the lamina into unequal portions; the secondary veins exhibit the same kind of anastomoses as in the longer segments of Pl. XVIII. Fig. 4. The general appearance of these specimens reminds one of the small leaves in *Pavia* and other Dicotyledons, which are intermediate between bud-scales and true foliage leaves. The question of the specific identity of these smaller forms and the longer-leaved type has been discussed in the introductory remarks on *Sagenopteris Phillipsii.*

Scarborough. *Bean Coll.*

39,311. Pl. XVIII. Fig. 3.

A single obcordate segment attached to a fairly broad petiole, which ends basally in a clean-cut surface evidently representing the actual base of attachment. The specimen is 3 cm. long. There is no definite midrib, but the lamina is traversed by spreading and anastomosing veins. Bunbury refers to this specimen in his remarks on *Sagenopteris cuneata*, L. & H. A similar specimen, in which a short petiole terminates in a single leaflet, may be seen in the Scarborough Museum.

39,221. Text-fig. 25; Lindley & Hutton, pl. lxiii. fig. 1.

This is certainly the type-specimen of fig. 1 in pl. lxiii. of Lindley and Hutton; the original drawing is reversed, and the venation characters are not accurately shown, the meshes being much too large. The preservation of this example is remarkably good;

[1] For a figure of the type-specimen of Lindley & Hutton, vide Seward (00), pl. iii. fig. 7.

there are four leaflets, shorter and broader than those in 39,222 (Text-fig. 24), borne on a common petiole; each leaflet is about 4·5 cm. long and 1·6 cm. broad, with a distinct midrib and long narrow meshes formed by the secondary veins. This type of leaf forms a more or less intermediate form between the long and narrow type shown in Text-fig. 24 and the large segment represented in Text-fig. 26. There is a striking resemblance between this specimen and some of the figures of *Sagenopteris rhoifolia* as published by Schenk; it emphasizes the very close



Fig. 25.—*Sagenopteris Phillipsi* (Brongn.). From a block lent by the University Press, Cambridge. No. 39,221. (Slightly reduced.)

agreement between the Lower Oolite and Rhætic species, which indeed can hardly be separated by any satisfactory characteristics.

Gristhorpe Bay. *Bean Coll.*

Text-fig. 26. *S. Phillipsi* (Brongn.), var. *major*, mihi.

The original of this figure is in the Scarborough Museum; there is a similar but rather smaller example in the British Museum Collection, No. 40,468, but a still longer specimen occurs in the Manchester Museum,[1] measuring about 11 cm. long; the figured specimen measures 8;5 cm. in length and 2 cm. in breadth. There is a close agreement between this leaflet and those of

[1] Seward (00), pl. iii. fig. 8.

Sagenopteris Goeppertiana figured by Zigno.[1] The midrib is well marked in the lower part of the leaf, but it gradually dies out towards the distal end of the lamina. Cf. also Nathorst's figures of *S. rhoifolia* from Sweden.[2]

Other specimens:—**10,378.** Portions of three leaflets broader than **39,222** (Text-fig. 24), but narrower than **39,221** (Lindley & Hutton, pl. lxiii. fig. 1), **40,468, 40,469, 40,558.**



Fig. 26.—*Sagenopteris Phillipsi*, var. *major*. From a specimen in the Scarborough Museum. (Nat. size.)

Genus PACHYPTERIS, Brongniart.

[Prodrome, p. 49, and Histoire, p. 166, 1828.]

Brongniart instituted this genus in 1828, defining it as follows: 'Foliæ pinnatæ vel bipinnatæ, pinnulis integris coriaceis enerviis

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[1] Zigno (56), pls. xxi. and xxii.
[2] Nathorst (78[2]), pl. iv. fig. 2.

vel uninerviis, basi constrictis nec rachi adnatis."[1] He notes the form of the pinnules, which are never lobed, and the absence of veins as characteristic features. Brongniart and many other authors place *Pachypteris* among the ferns, but in 1845 Unger[2] included the genus among the "Cycadaceæ dubiæ," and Andrae[3] regarded it as a member of the Taxineæ. Zigno instituted the genus *Dichopteris* for ferns having bipinnate fronds characterized by a stout rachis bearing linear pinnæ with short lanceolate or ovate segments traversed by several veins. A specimen figured by this author as a portion of a fertile frond of *Dichopteris microphylla*, Zigno,[4] has been accepted by Schimper and others as definitely settling the fern-nature of the genus. This critical example I regard as a piece of a fertile frond of *Todites*; the pinnules agree in shape and in the arrangement of the sporangia with the fertile segments of *Todites Williamsoni* (Brongn.).[5] In 1873 Saporta proposed a new genus *Scleropteris* for several imperfectly known species previously referred to Pomel's genus *Laxopteris*, to *Sphenopteris*, *Dichopteris*, and *Pachypteris*.[6] It is probable that more than one generic type of plant is included in Saporta's genus; some of the species are undoubtedly ferns, while others, formerly referred to *Pachypteris* or *Dichopteris*, may possibly be Cycadean. In placing *Pachypteris* among the ferns of doubtful affinity, it is not intended to imply that the evidence available renders that position in any sense established. The argument advanced by Brongniart against Unger's reference of *Pachypteris* to the Cycads, that no Cycad is known with bipinnate fronds, cannot be maintained; in the Australian genus *Bowenia* we have a well-known instance of a Cycad with bipinnate leaves, and it is very probable that this form of leaf was not infrequently borne by stems having the structure of Cycads. Recent research has thoroughly established the closest affinity between Cycadean and Filicinean types in the Palæozoic epoch, and there is evidence that during the Mesozoic period the distinction between Ferns and

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[1] Brongniart (28[2]), p. 166.
[2] Unger (45), p. 165.
[3] Andrae (53), p. 43.
[4] Zigno (56), pl. xv. fig. 5.
[5] Vide ante, p. 90.
[6] Saporta (73), p. 364.

Cycads was much less marked than at the present day. It may well be that *Pachypteris* is an extinct type in which fern-like fronds were attached to a stem possessing the structure of a Cycad. We have recently been taught to recognize the intimate association, and indeed the common origin, of Ferns and Cycads, and we cannot expect, in dealing with fronds alone, to be able to draw a sharp line of distinction between these two classes of the plant-kingdom. The view that *Pachypteris* may represent an extinct genus intermediate between Cycads and Ferns was held by Braun in 1854, and this may well be the nearest approach to the truth. In a recent paper on Cretaceous plants from Lesina, Krasser[1] has given the history of the genus *Pachypteris*; this author discusses at length the affinity of the genus, which he includes among the Cycadaceæ.

Pachypteris lanceolata, Brongniart.

[Hist. vég. foss. p. 167, pl. xlv. fig. 1, 1828.]

(Text-figs. 27 and 28.)

1828. *Pachypteris lanceolata*, Brongniart, Prodrome, p. 50.
P. ovata, ibid.
P. lanceolata, Brongniart, Hist. vég. foss. p. 167, pl. xlv. fig. 1.
P. ovata, ibid. p. 168, pl. xlv. fig. 2.
1829. *Sphenopteris? lanceolata*, Phillips, Geol. Yorks. p. 153, pl. x. fig. 6.
Neuropteris lævigata, ibid. p. 154, pl. x. fig. 9.
1836. *Pachypteris lanceolata*, Göppert, Foss. Farrn. p. 179, pl. i. fig. 4.
P. ovata, ibid.
1838. *Pachypteris lanceolata*, Sternberg, Flor. Vorwelt, fasc. vii. p. 55.
P. ovata, ibid.
1845. *Pachypteris lanceolata*, Unger, Syn. Plant. Foss. p. 165.
P. ovata, ibid.
1848. *Pachypteris lanceolata*, Bronn, Ind. Pal. p. 891.
1849. *Pachypteris lanceolata*, Brongniart, Tableau, p. 105.
P. ovata, ibid.
1850. *Pachypteris lanceolata*, Unger, Gen. spec. foss. p. 307.
P. ovata, ibid. p. 308.
1852. *Pachypteris lanceolata*, Ettingshausen, Abh. k.-k. geol. Reichs. vol. i. Abth. 3, p. 3.
1854. *Pachypteris lanceolata*, Morris, Brit. Foss. p. 14.

[1] Krasser (95).

1856. *Pachypteris lanceolata*, Zigno, Flor. foss. Oolit. vol. i p. 73.
Dichopteris lanceolata, ibid. p. 118, pl. xiv. fig. 2.
Pachypteris ovata, ibid. p. 74.
Dichopteris lævigata, ibid. p. 118, pl. xiv. fig. 3.
1869. *Pachypteris ovata*, Schimper, Trait. pal. vég. vol. i. p. 492.
1873. *Scleropteris Phillipsii*, Saporta, Pal. Franç. p. 369, pl. xlv. fig. 2.
S. lævigata, ibid. p. 370, pl. xlvi. fig. 3.
Pachypteris lanceolata, ibid. p. 366, pl. xlv. fig. 1.
P. ovata, ibid. p. 370, pl. xlvi. fig. 2.
1875. *Dichopteris lanceolata*, Phillips, Geol. Yorks. p. 200, pl. x. fig. 6.
D. lævigata, ibid. p. 201, pl. x. fig. 9.
1876. Cf. *Pachypteris brevipinnata*, Feistmantel, Pal. Ind. pl. iii. fig. 7; pl. iv. figs. 1–3.
1879. Cf. *Dichopteris ellorensis*, ibid. pl. ii. figs. 8–10.
1892. *Pachypteris* (*Dichopteris*) *lanceolata*, Fox-Strangways, Tab. Foss. p. 131.
1895. *Pachypteris ovata*, Krasser, Jahrb. geol. Reichs. Wien. vol. xlv. p. 42.

Type-specimens. The type-specimens of Phillips are said to be in the York Museum, but I was unable to identify them among the plants in that collection. The example figured by Saporta [(73), pl. xlv. fig. 3] is in the Scarborough Museum (Text-fig. 28).

Frond bipinnate; rachis stout; the linear pinnæ bear thick ultimate segments obliquely inclined to the axis, lanceolate or of narrow oval form with an entire or slightly lobed margin; veins very indistinct, probably more than one in each pinnule.

The material afforded by the East Yorkshire plant-beds is too fragmentary and insufficient to enable us to give a satisfactory diagnosis of the species to which the English specimens are referred. It is not improbable that more than one specific type is represented by the two examples shown in Text-figs. 27 and 28, but in view of the meagre data and the probable variation in the form of the pinnæ and pinnules in one large frond, it is wiser to refrain from any attempt at specific separation.

The specimens which Brongniart named *Pachypteris lanceolata* and *P. ovata* were obtained from a locality near Whitby; they are specifically identical with the portions of fronds figured by Phillips in 1829 as *Sphenopteris ? lanceolata* and *Neuropteris lævigata*. Saporta, in discussing the English specimens, points out that Brongniart's description of the pinnules as being without visible veins, or as having a single vein, is not accurate, the lamina of each ultimate segment being traversed by several veins.

The few fragments of *Pachypteris* obtained from English localities

do not afford any evidence of the existence of a single midrib in the pinnules, as figured by Brongniart. In all probability the thick pinnules were traversed by several veins, as shown in Zigno's figures of Italian specimens. Saporta considers *Pachypteris ovata* of Brongniart identical with *Neuropteris lævigata* of Phillips, and changes the latter name to *Scleropteris lævigata*; the figure



FIG. 27.—*Pachypteris lanceolata*, Brongn. From a specimen in the Whitby Museum, No. 2376. (Nat. size.)

given by Saporta of this form is from a drawing by Williamson which was sent by him to Brongniart; it was evidently made from the Scarborough specimen shown in Text-fig. 28. There is a close agreement as regards the habit of the frond and the form of the pinnæ between a large specimen described by Saporta,

as *Scleropteris Pomelii*[1] from the Corallian of Verdun (Meuse) and the English species, but it is not clear that the two are identical. By far the best examples of *Pachypteris* are those described by



Fig. 28.—*Pachypteris lanceolata*, Brongn. From a specimen in the Scarborough Museum. (Nat. size.)

Zigno as species of *Dichopteris* from the Italian Oolite; in size and preservation they are greatly superior to the Yorkshire

[1] Saporta (73), p. 370, pls. xlvi. and xlvii.

specimens.[1] It is possible that *Pachypteris* (*Dichopteris*) *Visianica* (Zigno) is specifically identical with *P. lanceolata*. An interesting example of *Pachypteris* has been described more recently by Krasser from the Chalk of Lesina under the name *P. dalmatica*.[2]

Text-fig. 27.

This specimen (Whitby Museum, No. 2376) represents an imperfect pinna bearing thick pinnules, reaching a length of 1 cm., in which the veins cannot be detected.

Text-fig. 28.

The original of Williamson's drawing published by Saporta.[3] As in the Whitby specimen, the veins are not visible; in this example several of the segments have a slightly lobed margin, and bear a striking resemblance to those of *Scleropteris Pomelii*, Sap.[4]

[1] Zigno (56), pls. xii. and xiii.
[2] Krasser (95), p. 47, pl. ii.
[3] Saporta (73), pl. xlv. fig. 3.
[4] Loc. cit. pl. xlvii.

Group GYMNOSPERMÆ.

Class CYCADALES.

The term Cycadales is used as a comprehensive designation to include certain fossil genera which are usually spoken of as Cycads, but do not conform to the accepted definition of the existing Cycadaceæ. It is well known that the Mesozoic Period was characterized botanically by the abundance of plants bearing pinnate fronds very similar to those of recent Cycads. These extinct types, at least in some cases, have been shown to differ essentially from the modern Cycadaceæ in their reproductive structures, which diverge too widely from the type represented by the flowers of living Cycads to admit of the inclusion of the fossil genera in the family Cycadaceæ. It has been found convenient, therefore, to make use of the class-name Cycadales to include both the existing Cycadaceæ and certain fossil genera of which the floral structures are known, with others with which we are acquainted only as regards their leaves or stems.

Amongst the Jurassic Cycadean genera we have the type *Williamsonia*, which is of special interest as representing an extinct division of the Cycadales definitely marked off from the true Cycads by the morphology of the floral organs; this division is spoken of as the Bennettiteæ. Other Cycadean genera abundantly represented in the Jurassic flora cannot at present be referred with certainty either to the Bennettiteæ or to the Cycadaceæ; these may be dealt with as types of Cycadales, without being included in either of the two families or divisions. It is probable that the genus *Anomozamites*[1] should be included with *Williamsonia* as a member of the Bennettiteæ.

[1] Nathorst (88).

Family BENNETTITEÆ.

Under this head we include the genus *Williamsonia*, which may be conveniently retained as a Mesozoic type closely allied to *Bennettites*. There appears to be good evidence also in favour of including the genus *Anomozamites* in the Bennettiteæ. In the second volume of the *Wealden Catalogue*[1] I have used *Williamsonia* in the sense of a subgenus of *Bennettites*, and it is possible that this is the wiser course to adopt; on the other hand, we are less intimately acquainted with the plants usually referred to *Williamsonia* than with the original species of *Bennettites*, and it is a convenience to retain the former name as denoting a member of the Bennettiteæ which has long been known as a Jurassic genus of doubtful affinity.

Genus WILLIAMSONIA, Carruthers.

[Trans. Linn. Soc. vol. xxvi. p. 691, 1870.]

1. Williamsonia gigas (Lindley & Hutton).
2. Williamsonia pecten (Phillips).

The history of *Williamsonia* was dealt with at length in the second volume of the *Wealden Catalogue*, and need not be recapitulated.[2] Since my account of *Williamsonia* was written I have had an opportunity of examining several specimens of the genus, and from some of them, more particularly from English examples in the Natural History Museum, Paris, I have been able to satisfy myself that Williamson's restoration of the Yorkshire Oolite plant[3] — *Williamsonia gigas* — is in essentials correct. The pinnate Cycadean fronds described in 1835 as *Zamia gigas* were undoubtedly borne on a stem which presented an appearance practically identical with that of most recent Cycads; the same stem also bore flowering shoots which terminated in flowers

[1] Seward (95), p. 146.
[2] Seward (95), pp. 146–157.
[3] Williamson (70), pl. liii.

which were named by Carruthers *Williamsonia*. I have elsewhere dealt more fully with the evidence on which this conclusion is based.[1]

1. Williamsonia gigas (Lindley & Hutton).

[Foss. Flor. vol. iii. pl. clxv. 1835.]

(Pl. V.; Pl. VI. Fig. 2; Pl. VII.; Pl. VIII. Fig. 1; Text-fig. 29.)

1828. *Zamia Mantelli*, Brongniart, Prodrome, p. 94.
1835. *Zamia gigas*, Lindley & Hutton, Foss. Flor. pl. clxv.
1836. *Odontopteris falcata*, Göppert, Foss. Farrn. p. 210.
1838. *Odontopteris falcata*, Sternberg, Flor. Vorwelt, vii. p. 78, pl. xxiii. fig. 1.
Zamites falcatus, ibid. p. 197.
1841. *Zamites gigas*, Morris, Annals, vol. vii. p. 116.
Ptilophyllum falcatum, ibid. p. 118.
1842. *Encephalartos gigas*, Miquel, Mon. Cycad. p. 61.
1844. *Zamites gigas*, Mantell, Medals of Creation, p. 116.
1848. *Zamites gigas*, Bronn, Ind. Pal. p. 1378.
1849. *Zamites gigas*, Brongniart, Tableau, p. 106.
Podozamites gigas, ibid. p. 62.
P. falcatus, ibid.
Zamites Moreaui, ibid. p. 106.
1850. *Zamites gigas*, Unger, Gen. spec. plant. foss. p. 283.
1853. *Zamites Schmiedelii*, Andrae, Foss. Flor. Sieben. pl. ix.
1854. *Zamites gigas*, Morris, Brit. Foss. p. 25.
1864. *Zamites gigas*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
1865. Cf. *Zamites Renevieri*, Heer, Urwelt Schweiz, p. 144, fig. 95.
1870. *Williamsonia gigas*, Carruthers, Trans. Linn. Soc. vol. xxvi. p. 693.
Zamites gigas, Schimper, Trait. pal. vég. vol. ii. pp. 105 and 205.
Zamites gigas, Williamson, Trans. Linn. Soc. vol. xxvi. p. 663.
1873. *Zamites gigas*, Zigno, Flor. foss. Oolit. vol. ii. p. 41.
1875. *Zamites gigas*, Saporta, Pal. Franç. vol. ii. p. 87, pl. lxxxi. fig. 1.
Z. Feneonis, ibid. p. 99, pls. lxxxvii.–xcii.
Z. claravallensis, ibid. p. 108, pl. xxiii. fig. 1.
Z. Moreaui, ibid. pl. lxxxiv. figs. 1 and 2.
Z. Renevieri, ibid. pl. xciii. fig. 2.
Williamsonia gigas, Phillips, Geol. Yorks. p. 225, lign. 53, pl. xxiv.
1876. ? *Zamites Feneonsis*, Heer, Flor. foss. Helvet. pl. lii.
1877. *Williamsonia* cf. *gigas*, Feistmantel, pl. xliv.
1881. *Zamites gigas*, Renault, Cours bot. foss. vol. i. p. 54.
Z. Feneonis, ibid. p. 54, pl. v. fig. 4.
Z. Moreaui, ibid. p. 54, pl. vi. fig. 5.

[1] Seward (97).

1883. *Williamsonia gigas*, Williamson, R. Instit. Gt. Brit. 1883, p. 3, figs. 1–4.
1889. Cf. *Williamsonia virginiensis*, Fontaine, Potomac Flora, p. 273, pls. cxxxiii. and clxv.
1890. *Zamites gigas*, Schenk, in Zittel, p. 218.
Williamsonia gigas, ibid. p. 219.
1892. *Williamsonia gigas*, Fox-Strangways, Tab. Foss. p. 142.

Type-specimens. The specimens of flowers figured by Williamson are in the possession of Mrs. Crawford Williamson. Those figured by Phillips and by Young & Bird are in the Whitby Museum. [The original of Mantell's figure of the flower published in the *Medals of Creation* (p. 16) is in the Museum of Practical Geology, Jermyn Street, London.]

Main stem similar to the ordinary type of Cycadean trunk in being covered with persistent bases of petiole. Leaves pinnate, agreeing in habit with the fronds of most recent species of Cycadaceæ; the crowded linear lanceolate pinnæ with acuminate apices are attached to the upper face of the rachis by their slightly rounded bases, which were probably swollen, as in several recent species in which the pinnæ possess a basal callosity. The stiff lamina of the pinnæ is traversed by several parallel, or slightly spreading, and occasionally forked veins. The lower part of the rachis is prolonged below the basal pinnæ as a petiole attached by a swollen base to the stem. The pinnæ are for the most part given off from the rachis at a wide angle; in the lower portion of the frond the pinnæ are shorter and broader and almost at right angles to the axis; in the middle of the frond they are more crowded, longer, and given off at an acute angle, while towards the apex of the frond they are narrower, and attached at a much more acute angle, or almost parallel to the rachis.

From the main stem were given off one or more comparatively slender branches ('peduncles') bearing linear acuminate scale-leaves often clothed with ramenta; each of these branches terminated in an ovoid flower surrounded by linear bracts, and probably agreeing in structure with the flower of *Bennettites*.

The above description is far from complete, but it is intended to convey a general rather than a detailed view of the plant as a whole. In all probability the flowers of the genus *Williamsonia* agreed in essentials with those of the Lower Cretaceous and Wealden *Bennettites*, but unfortunately the absence of internal structure

prevents us speaking with certainty as to the floral characters of *Williamsonia gigas*. During the last few years numerous silicified stems of *Bennettites* have been discovered in North American beds, and a preliminary account of the flowers of some of these species by Mr. Wieland,[1] of Newhaven, leads us to look forward with considerable interest to the publication of his more detailed work. One of the most interesting points brought to light by Wieland's work concerns the nature of the male reproductive organs. I am indebted to the courtesy of this investigator for a section through the male sporophylls of a flower, which shows very clearly several sporangia containing microspores (pollen-grains). The microspores bear a striking resemblance to those of recent Cycads.

In describing the specimens of *Williamsonia gigas* in the British Museum, I have drawn attention to several features which enable us to obtain a fairly comprehensive view of the external characters of this interesting type of the Bennettiteæ.

The specific name *Zamia Mantelli* instituted in 1828 by Brongniart was afterwards quoted by this author as a synonym of *Zamites gigas*, L. & H. For this reason, and because the latter name has been generally adopted, the older specific designation is discarded. The earliest figure of an English specimen of this species was published by Young & Bird in 1822.[2] The fronds of *Williamsonia gigas* (L. & H.) represent a type of Cycadean foliage which was abundant and widely distributed during the Jurassic period; it is very difficult to decide which of the many pinnate fronds of the *Zamites* type should be included under *W. gigas*. Some at least of the fronds described by French authors from Jurassic rocks are no doubt specifically identical with the Yorkshire plant, but it is not improbable that other species, not included in the above synonymy, might reasonably be referred to the English type. A collection of Yorkshire specimens in the Natural History Museum, Paris, contains some of the most important examples of *Williamsonia gigas*, and an examination of these fossils has aided me considerably in forming an opinion as to the close affinity of *Williamsonia* with *Bennettites*.

[1] Wieland (99[2]).

[2] Young & Bird (22), pl. ii. fig. 2. The original specimen (No. 8344) is in the Whitby Museum.

The late Professor Williamson devoted a considerable time during the earliest years of his scientific life to the investigation of the fossils to which Carruthers gave the name *Williamsonia.* No one has had opportunities of studying this genus as it occurs in the rocks near Scarborough equal to those enjoyed by Williamson ; and it is interesting to find that the most recent work has tended to support many of the conclusions arrived at by this observer. As early as 1834 Williamson[1] expressed the opinion that *Zamites gigas* was connected with *Williamsonia*, and in his very able paper, published in 1870,[2] this author is confirmed in the view of the organic connection of these two sets of fossils. This opinion was shared also by Brongniart,[3] who received an unusually fine collection of English Williamsonias from the late Mr. Yates. These specimens are now in the Natural History Museum, Paris, and many of them were drawn for Brongniart with a view to publication, but the work was unfortunately never completed. The drawings were afterwards made use of by Saporta in his comprehensive work on Jurassic plants. In describing the Yates specimens, Saporta expresses himself strongly against the generally accepted view as to the union of *Williamsonia* and *Zamites.* He does not hesitate to separate the *Zamites* fronds from any connection with the Williamsonias. There is, he admits, " une certaine conformité apparente entre les appareils floraux auxquels on peut laisser le nom de *Williamsonia* et le *Zamites gigas*, tel que le fait voir le remarquable empreinte de la collection du Muséum de Paris (voy. pl. lxxxi. fig. 1). Nous avons tout bien de considérer les *Williamsonia* comme représentant l'inflorescence d'une monocotylédone primitive, révélant un type de Pandanées plus ou moins analogue aux *Yuccites*, aux *Podocarya*, aux *Eolirion* de Andrae, etc."[4]

A recent examination of the Yates Collection in Paris, and a comparison of the numerous specimens in the Museums of London, Cambridge, Whitby, Scarborough, Leeds, and other towns, have led me without hesitation to regard the pinnate Cycadean

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[1] Williamson (37), p. 230.
[2] Williamson (70), p. 663.
[3] Brongniart (49), p. 62.
[4] Saporta (75), p. 55.

fronds of *Zamites gigas* as the leaves of the plant which bore a Williamsonian inflorescence.

One not infrequently finds a small bud or young *Williamsonia* borne on the end of a peduncle about 20 or 30 cm. long and 3 to 5 cm. broad. The peduncle is covered with linear lanceolate scale-leaves spirally disposed and often clothed with delicate hair-like ramenta, such as occur on the scale-leaves of *Dioon* and other recent Cycads. A peduncle of this kind is figured by Saporta in pl. xv. of vol. iv.[1] The original is in the Paris Museum; the scale-leaves are less prominent and not so thick as those shown in the drawing, and in this and other specimens one sees traces of the ramental appendages. The best example of a peduncle is included in the series of specimens of *Williamsonia* now in the possession of Mrs. Crawford Williamson, to whom my thanks are due for an opportunity afforded me of examining the fossils figured in Professor Williamson's valuable memoir.

Saporta alludes to the resemblance of the peduncle which he figures to the stem of *Zamites gigas*,[2] represented in his volume on Cycads (pl. xi. fig. 1), but he does not regard the similarity as evidence of relationship or identity. This specimen of *Zamites* referred to in the above quotation, from the second volume of the *Plantes Jurassiques*, is of exceptional interest and furnishes the most important link in the argument in favour of the connection between *Williamsonia* and *Zamites gigas*. Saporta's figure is very imperfect, and conveys but a poor and erroneous idea of the actual specimen. In the lower part of the figure is shown a stem about 5 cm. broad, with the surface features indistinctly preserved, but showing a number of imperfect scale-leaves. To one side of the stem, 5 cm. from the bottom of the specimen, are attached the petioles of two clearly preserved fronds of *Zamites gigas*, and above these occurs part of a third frond apparently in its natural position but without the petiolar attachment. The stem is prolonged obliquely upwards to the left in the form of a branch about 3 cm. broad and 14 cm. long. This branch is thickly clothed with hairy leaf-scales, and terminates in numerous spreading leaf-scales of a narrow linear lanceolate form. The position and surface features of this branch

[1] Saporta (91).
[2] Saporta (75), p. 55.

are very inadequately and incorrectly reproduced in Saporta's figure. If we now turn to the specimen figured by the same author as a peduncle of *Williamsonia*,[1] and which terminates in what appears to be a closed Williamsonian inflorescence, we find the characters are identical with those of the branch of the stem which bears the *Zamites* fronds. Specimens of peduncles in the British Museum, and others in the collections of Whitby, Scarborough, and Leeds, afford similar proof of the identity of the detached peduncles and the obliquely placed branch of the leaf-bearing stem. There can be little doubt that the terminal bud-like structure on these peduncles is a young and unexpanded *Williamsonia*, but even if this be disputed, there can be no question as to the identity of the typical scale-leaves of *Williamsonia* and those of the terminal bud on the peduncles.

A specimen in the Whitby Museum shows a stem bearing two diverging peduncles, and evidence of the same habit of growth is afforded by an example in the British Museum. In all probability the stem figured by Saporta[2] bore another peduncle in addition to that shown in the figure; this is suggested not only by the examination of other specimens but also by the oblique position of the peduncle, which is not brought out in the figure. The restoration of *Zamites* given by Williamson in his well-known paper[3] accurately represents what I believe to have been the manner of attachment of the inflorescence and foliage-leaves to the main stem.[4]

The whole subject of the Bennettiteæ and other fossil Cycadales will be more fully dealt with in a forthcoming monograph on British Cycads to be published by the Palæontographical Society.

Specimens of both the fronds and flowers of *Williamsonia gigas* are abundantly represented in the British Museum, and in the Natural History Museum, Paris. Examples of fronds in the Newcastle and Paris Museums suggest that the segments had an imbricated arrangement in the young condition. Specimens of peduncles are by no means common; the best are those in the Museums of Paris, Cambridge, Scarborough, Whitby, and Leeds. No undoubted

[1] Saporta (91), pl. xv.
[2] Saporta (75), pl. xi. fig. 1.
[3] Williamson (70), pl. liii.
[4] Seward (97), pp. 274–7.

examples of seeds have been discovered in connection with the reproductive organs, but in a transverse section cut through a small flower at the apex of a peduncle (Scarborough Museum) one or two oval depressions were noticed, which may be due to the presence of small seeds. The best examples of *Williamsonia* flowers are those in the Yates Collection, Paris, and the specimens figured by the late Professor Williamson, which are now in the possession of Mrs. Crawford Williamson.

a. Fronds and Stem.

V. 2723*a*. Pl. V. (and Pl. VII. Fig. 2).

This is a good example of a small frond of *Williamsonia gigas*; it measures 23 cm. in length, and illustrates the characteristic habit of the leaf and the form and manner of attachment of the pinnæ. The rachis is comparatively slender, and bears on its upper surface numerous alternately disposed linear lanceolate pinnæ with rounded bases and acuminately pointed tips; the basal portion of some of the pinnæ is slightly hollowed out in the centre and suggests the original presence of a callus. At the apex of the frond the pinnæ are narrow and linear, and at the actual tip they are almost parallel to the rachis; in the lower portion of the frond the pinnæ are shorter and broader, and approximately at right angles to the rachis, while in the middle of the frond they are more crowded, longer, and given off at a different angle.

This frond should be compared with Saporta's figures of *Zamites Feneonis*, Brongn.,[1] which I regard as specifically identical with *Williamsonia gigas*, and with Andrae's figures of *Zamites Schmiedelii*, Sternb.[2]

V. 2722*a*. Pl. VII. Fig. 4.

This figure shows the swollen base of a petiole of a frond more than 60 cm. in length, of which the apical portion has not been preserved; when complete, it must have been about 80 cm. long. The petiole has a length of 11 cm., and terminates below in a thick, irregularly oval base.

Yorkshire. *Beckles Coll.*

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[1] Saporta (75), pls. lxxxvii.–xci.

[2] Andrae (53), pl. ix.

11,020. Pl. VII. Fig. 6.

Part of a frond 21 cm. in length. The small piece shown in the figure illustrates the rounded form of the pinna base and the median concavity, indicating the existence of a callus or basal thickening at the point of attachment to the rachis. It shows also the slightly spreading veins, which throughout the greater part of each pinna follow a course approximately parallel to the long axis of the pinna.

Oolitic Shale, Gristhorpe Bay. *Mantell Coll.*

V. 2609*a*. Pl. VI. Fig. 2.

Well-preserved examples of the stem of *Williamsonia gigas* are rarely met with; the figure represents the only specimen in the British Museum Collection in which any surface-features are shown. A similar specimen may be seen in the Woodwardian Museum, Cambridge (Leckenby Coll., No. 203). The persistent leaf-bases are shown as spirally disposed projecting areas recalling the appearance of recent Cycadean stems; the concave termination at the top of the specimen probably represents the position of a flowering axis such as we know were borne by the stems of *Williamsonia.* The stem measures 9 cm. in length and 5·5 in breadth. Fragments of fronds and flowers are associated with this piece of stem, and on the reverse side of the specimen there is a good example of a disc like that of 38,785 (Pl. VIII. Fig. 1).

Yorkshire. *Beckles Coll.*

V. 3514. Pl. VII. Fig. 5.

A part only of the specimen is represented in the figure; there is not enough of the frond preserved to enable one to be quite sure as to its identity with *Williamsonia gigas* or *Otozamites acuminatus*; but the rounded edges of the pinnæ bases and the absence of any definite *Otozamites* 'ear' point to *Zamites* as the generic type rather than to *Otozamites.* Cf. *Otozamites Klipsteini* (Dunk.) as figured in pl. vii. of the *Wealden Flora.*[1]

V. 2722. Good examples of long fronds, which illustrate the

[1] Seward (95), pl. vii.

difference in form and manner of attachment of the apical, median, and basal pinnæ. The longer central pinnæ have a length of 7·5 cm., those at the base are about 3·5 cm. long, while the apical pinnæ are longer, more linear, and less pointed.

V. 2723. A fine frond similar to **V. 2722.** *Beckles Coll.*

V. 3507. Good fronds with broad pinnæ showing clearly preserved venation; the pinnæ are oblique to the matrix, and therefore appear narrower than they really are, and at first sight they suggest an *Otozamites* rather than a *Zamites* type. *Purchased.*

V. 3942. A frond 53 cm. long. This specimen is preserved in sandstone, and does not show the details so clearly as many of the other examples of this species, but it affords a good illustration of the danger of relying too much on the published figures of fossil fronds. If this frond were drawn as it appears on the sandstone, the pinnæ would seem to have broad basal portions rapidly tapering towards the apex; in reality the breadth of the pinnæ is fairly uniform to within a short distance of the apex, but owing to the oblique position of the pinnæ in the sandstone matrix, a considerable portion of the lower edges is hidden and would not be seen in a drawing or photograph.

38,760. A splendid frond 45 cm. in length, including the petiole, which measures 4·5 cm., widening towards the base. This frond is unusually complete, showing both the apical and basal pinnæ. The tips of the pinnæ are seen to vary considerably: in some the upper and lower margins bend gradually downwards and upwards respectively towards the symmetrically placed acuminate apex; in some the apex points upwards; and in others the lower margin of the pinnæ is almost straight, while the upper margin bends strongly downwards and gives the apex the appearance of pointing slightly downwards.

Scarborough.

38,761. Good examples of fronds associated with a flower of oval form and closely invested by linear bracts, many of which show the obliquely set ramenta, which are frequently met with on the bracts of *Williamsonia gigas.*

39,093. Portions of fronds. On the same piece of rock there is a good impression of a large *Equisetites* stem, probably *E. Beani*, in which the leaf-sheaths are clearly preserved.[1]

Runswick Bay. *Presented by S. P. Pratt, Esq.*

Other specimens:—**V. 2115** (fronds associated with fragments of flowers), **V. 2887** (pieces of fronds and a peduncle), **V. 3508, V. 3511, V. 3928, 38,779, 39,200, 39,295** (cf. Saporta's figures of *Zamites claravallensis*[2] and *Z. Feneonis*[3]).

b. Flowering Axes and Floral Organs.

V. 2723*a*. Pl. VII. Fig. 2 (and Pl. V.).

The figured specimen, which occurs in association with the frond shown in Pl. V., consists of a flowering axis or peduncle, 16 cm. long, covered with compressed bracts bearing ramenta; the peduncle has a diameter of about 3 cm. The summit of the axis was originally occupied by a flower or bud, of which the basal portion only has been preserved. One of the best specimens of a branch of this kind I have met with is in the Leeds Museum.

Beckles Coll.

46,633. Pl. VII. Figs. 1 and 3, and Text-fig. 29.

Fig. 1 represents part of a peduncle of the same type as that shown in Fig. 2, but preserved in such a manner as to show the individual linear bracts, which are identical in surface-markings and shape with the involucral bracts of a flower. The central or axial part of the peduncle has not been preserved; the figured portion shows the cavity originally occupied by the axis, surrounded by very clearly preserved scale-leaves which thickly covered its surface. In Fig. 3 one of the scale-leaves (*x* in Fig. 1) is shown on a larger scale: it has the form of a hollow shell with a compressed lozenge-shaped central portion, which was originally occupied by the ground tissue and vascular bundles; the shell no doubt represents the more resistent sclerenchymatous hypoderm, the surface-striations being the expression of the longitudinal course of the bands of mechanical tissue which occurred below the epidermis.

[1] Vide ante, p. 67.
[2] Saporta (75), pl. xxiii. fig. 1.
[3] Ibid. pl. xx. fig. 3.

Portions of two other peduncles occur on the same piece of rock; also a very good specimen of a *Williamsonia* 'head' or flower. The flower shows the central pyriform and tapering cavity surrounded at the base by the characteristic zone marked by radiating lines, and enclosed by numerous linear bracts. The specimen is practically identical with that represented in pl. lii. fig. 6 of Williamson's Memoir.[1]

Several pieces of fronds occur in association with the peduncle and flower.

In Text-fig. 29 we have a sketch of the broken end of the axis of the peduncle, shown in Fig. 1, Pl. VII., as seen in looking upwards along the cavity left on the removal of the



FIG. 29.—*Williamsonia gigas* (L. & H.). View of the truncated end of the peduncle shown in Pl. VII. Fig. 1. No. 46,633. (× 1½.)

lower part of the peduncle. In the upper portion (*c* in Fig. 1, Pl. VII.) the axis itself has been preserved, and the truncated end is shown in the Text-figure; the axial portion is elliptical in shape, and is surrounded by the linear scale-leaves, which in Fig. 1 are seen in surface-view; these bracts are represented in the Text-figure by somewhat crushed shells of hypodermal tissue enclosing spaces bounded on the outside by convex walls, and internally, where the bracts are in contact with the axis, by more or less straight walls, as shown in the upper part of the figure.

38,785. Pl. VIII. Fig. 1, and **38,784.**

These two specimens, one the reverse of the other, illustrate the form of an unusually large example of that part of the floral organ which Williamson named the carpellary disc; the same

[1] Williamson (70).

structure has also been figured by Saporta as "une expansion infundibuliforme."[1]

The disc was originally circular, as we know from other specimens, the centre being shown at the base of the figure in Pl. VIII. As seen in surface-view, the disc has the form of a cup-shaped, irregularly striated, carbonaceous membrane, breaking up at the periphery into several long and tapering bracts. The continuous portion of the disc has a diameter of 8·5 cm. It is probable that this organ was originally attached to the summit of a *Williamsonia* flower, but we have no satisfactory evidence as to its function.[2] Portions of fronds occur on the same piece of rock as the disc shown in Fig. 1, Pl. VIII.

Oolitic Ironstone, Saltwick. *Bean Coll.*

V. 2507. Imperfect flowers, in which the scale-leaves show the irregular and occasionally anastomosing ridges, which are no doubt due to the presence of strands of hypodermal stereome.

Purchased.

V. 2887. Basal view of flowers, showing bracts and ramenta.

V. 2887*a*. A peduncle, 18 cm. long, covered with imperfect scale-leaves and terminating in a bud enclosed by scale-leaves identical with the involucral bracts of the detached flowers. Numerous pinnæ occur on the same piece of rock.

Near Scarborough. *Beckles Coll.*

V. 3512. Similar to **V. 2887**, with short and broad involucral bracts.

13,512. The impression of a disc with peripheral bracts, similar to the example shown in Pl. VIII. Fig. 1 (**38,785**).

Haiburn Wyke. *Presented by Dr. Murray.*

Other specimens:—**V. 2609**, **V. 3513** (fragments of flowers and fronds), **39,087**, **39,094**, **39,304**, **40,556**, **52,559**.

[1] Saporta (75), p. 148.

[2] Vide Seward (95), pp. 152, 153.

2. Williamsonia pecten (Phillips).

[Geol. Yorks. p. 148, pl. vii. fig. 22, 1829.]

(Pl. II. Fig. 7; Pl. III.; Text-figs. 30–35.)

1828. *Zamia Goldiæi*, Brongniart, Prodrome, p. 94.
1829. *Cycadites pecten*, Phillips, Geol. Yorks. p. 148, pl. vii. fig. 22.
C. pectinoides, ibid. p. 125, pl. x. fig. 4.
1834. *Pterophyllum pecten*, Lindley & Hutton, Foss. Flor. vol. ii. pl. cii.
1835. ? *Zamia taxina*, ibid. pl. clxxv.
1841. *Ptilophyllum pecten*, Morris, Annals, vol. vii. p. 117.
P. pectinoideum, ibid.
1845. ? *Zamites gracilis*, Kurr, Foss. Flor. Württ. pl. i. fig. 4.
1848. *Pterophyllum pecten*, Bronn, Ind. Pal. p. 1056.
P. pectinoides, ibid.
1849. *Zamites pecten*, Brongniart, Tableau, p. 106.
Otozamites Goldiæi, ibid.
1850. *Pterophyllum pecten*, Unger, Gen. spec. plant. foss. p. 289.
Cf. *Otozamites gramineus*, var. *Mundæ*, Morris, Quart. Journ. Geol. Soc. vol. vi. pl. xxvi. fig. 7.
1852. ? *Pterophyllum imbricatum*, Ettingshausen, Abh. k.-k. geol. Reichs. Bd. i. Abth. 3, pl. i. fig. 1.
1853. *Pterophyllum rigidum*, Andrae, Foss. flor. Sieben. pl. xi. fig. 1.
Zamites gracilis, ibid. pl. xi. figs. 4 and 5.
1854. *Palæozamia pecten*, Morris, Brit. Foss. p. 15.
1861. *Dioonites pecten*, Miquel, Prod. Syst. Cycad. p. 31.
1863. ? *Palæozamia acutifolia*, Oldham & Morris, Pal. Ind. pls. xx. and xxi.
Cf. Inflorescence of Cycad, ibid. pl. xxxii. fig. 12.
1864. *Palæozamia pecten*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77, pl. ix. fig. 4.
P. hastula, ibid.
Otopteris lanceolata, ibid. p. 78, pl. viii. fig. 4.
1870. *Ctenophyllum pecten*, Schimper, Trait. pal. vég. vol. ii. p. 144.
Williamsonia pecten, Carruthers, Trans. Linn. Soc. vol. xxvi. p. 694.
W. pecten, Williamson, ibid. p. 674.
1873. *Pterophyllum pecten*, Zigno, Flor. foss. Oolit. vol. ii. p. 15, pl. xxix. figs. 1 and 2.
Zamites Phillipsii, ibid. p. 46, pl. xxxii. figs. 1 and 2.
Otozamites Goldiæi, ibid. p. 66.
Cf. *O. Heerii*, ibid. p. 67, pl. xxxiii. figs. 1 and 2.
Cf. *Zamites Rotzoanus*, ibid. p. 39, pl. xxx. figs. 4 and 5.
1874. ? *Zamites speciosus*, Heer, Flor. foss. Arct. vol. iii. (2), pl. xvi. fig. 4.
1875. *Pterophyllum pecten*, Phillips, Geol. Yorks. p. 226, pl. vii. fig. 22.
Otozamites gracilis, ibid. p. 224, lign. 52.
O. Goldiæi, Saporta, Pal. Franç. vol. ii. p. 128, pl. xxv. fig. 1.
Cf. *O. latior* (pars), ibid. pl. xxvii.

1876. ? *Ptilophyllum cutchense*, Feistmantel, Pal. Ind. pls. iv.–vi.
1877. ? *Ptilozamites acutifolia*, Feistmantel, Pal. Ind. (77[1]), pl. xl. p. 65; (77[2]), pl. ii.; (?77[3]), pl. v.
? *Ptilophyllum cutchense*, ibid. (77[3]), pl. vi.
Cf. *P. tenerrimum*, ibid. (77[1]), p. 66, pl. xli.
? *Otozamites gracilis*, ibid. (77[3]), pl. vii.
? *O. angustifolius*, ibid. pl. vii.
Cf. *O. distans*, ibid. pl. vii.
1879. *Palæozamia acutifolium*, Feistmantel, Pal. Ind. (79), pls. x. etc.
Ptilophyllum cutchense, ibid. pls. ii. and ix.
Otozamites Hislopi, ibid. pl. vii. fig. 4.
1881. *Otozamites angustifolius*, Heer, Secc. Trab. Geol. Portugal, pl. ix. fig. 12.
1883. Cf. *Ptilophyllum oligoneuron*, Tenison-Woods, Proc. Linn. Soc. N.S.W. vol. viii. pl. vii. figs. 2 and 3.
1890. *Pterophyllum pecten*, Schenk, in Zittel, p. 223.
1892. *Williamsonia pecten*, Fox-Strangways, Tab. Foss. p. 142.
W. hastula, ibid.
Cf. *Ptilophyllum oligoneuron*, Jack & Etheridge, Geol. Queensland, pl. xvi. fig. 2; pl. xviii. fig. 11.
1900. *Williamsonia pecten*, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 20, pl. iii. fig. 6.

Frond pinnate, long and narrow; uniform in breadth and variable as regards the shape and size of the pinnæ. The crowded pinnæ are attached to the upper face of the rachis at a more or less acute angle; the bases of the pinnæ are either of the same breadth as the rest of the lamina and have rounded corners or, in some cases, the upper edge of the base is slightly expanded as a basal lobe similar to the auriculate base of an *Otozamites* pinna. The pinnæ vary in shape: some are short and comparatively broad, while others are long and narrow (vide Pl. III.), their apices are either gradually tapering and acuminate, or the upper margin may be almost straight and the lower edge suddenly curved upwards to the pointed tip. The veins are spreading at the base of the pinna and approximately parallel through the greater part of the lamina. The petiole is slightly expanded laterally towards the base, which separates by a clean-cut absciss-layer from the stem (vide Pl. III. Fig. 7).

The flowers appear to be of the same type as those of *Williamsonia gigas*, but of smaller size, and characterized by the shorter and proportionately broader linear acuminate or lanceolate bracts. The York Museum contains a specimen very similar to that shown in Text-fig. 32.

Although the pinnate fronds, which were named by Lindley & Hutton *Cycadites pecten* and *C. pectinoides*, have never been found in organic union with the type of *Williamsonia* described by Nathorst as *W. Leckenbyi*,[1] there can be little, if any, doubt that the latter is the flower of the plant which bore the well-known pinnate leaves long known by Phillips' name *Pterophyllum pecten*. The constant association of the small species of *Williamsonia* with these fronds is in itself a strong argument for their specific identity. The extremely variable form of the fronds is at once apparent if we examine carefully the numerous examples of this species in the various British and Continental collections. In addition to the specimens in the British Museum illustrating the frequent association of various forms of *Williamsonia pecten* on one piece of shale, equally instructive examples may be seen in the Museums of Scarborough, York, and Manchester. One slab of rock in the Scarborough Museum shows about thirty fronds in which there is considerable variation in the breadth of the pinnæ. Specimens in the Manchester Museum also demonstrate the variability of the species: one frond 24 cm. in length bears pinnæ with bluntly rounded bases and the upper basal edge distinctly lobed (auriculate) (cf. **V. 3516**, etc.), and in close association with this occur other examples in which the pinnæ are smaller and without a basal lobe. The fossils originally named by Brongniart *Zamia Goldiæi*, and afterwards figured by Saporta as *Otozamites Goldiæi*,[2] are, I have no doubt, specifically identical with *Williamsonia pecten*; but the latter name is very much better known, and the form of frond to which the designation *pecten* was first applied represents the more typical form. A Liassic *Otozamites* described by Lignier from Normandy as *O. Apperti*[3] may also be compared with *Williamsonia pecten*; the pinnæ are slightly lobed at the base, and, as Lignier points out, they resemble *Otozamites Goldiæi*.

An important question is the affinity of several Cycadean fronds from Indian beds, which Feistmantel included in the genus *Ptilophyllum*, proposed by Morris in 1840, with the English fronds usually referred to *Pterophyllum*, and now spoken of as *Williamsonia*

[1] Nathorst (80[2]).
[2] Saporta (75), pl. xx. fig. 1.
[3] Lignier (95), p. 22.

pecten. Morris defined *Ptilophyllum* as follows: "Fronds pinnate, pinnæ closely approximated, linear, lanceolate, more or less elongate, imbricate at the base, attached obliquely; base semicircular or rounded; veins equal, slender, parallel."[1] In this diagnosis there is nothing to justify a separation from the type represented by *Williamsonia pecten.* I have no hesitation in expressing the opinion that there is practically no difference between such fronds as *Ptilophyllum cutchense*, Morr., *P. tenerrimum*, Feist., *P. acutifolium*, Morr., and *Williamsonia pecten.*

A careful examination of Morris' type-specimen of *Ptilophyllum cutchense* (in the Museum of the Geological Society of London), and of several other Indian specimens in the British Museum, has convinced me that a generic separation of the Indian and European fossils serves to mislead and indicates a distinction which does not exist. It is by no means certain that the two sets of fossils are specifically identical; probably they are not, but there is at least no difference worthy of generic rank. In several instances there has been a tendency to exaggerate the difference between the Gondwana floras and the floras of corresponding age in Europe.

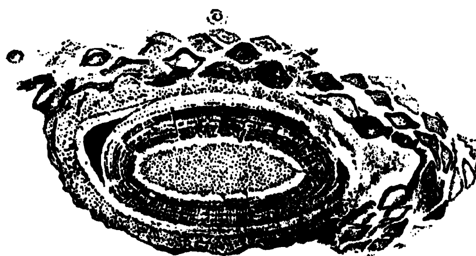
The occurrence of *Williamsonia* flowers in the Indian beds, and the existence of Cycadean stems like that shown in Text-fig. 30, demonstrate the close correspondence, as regards some members of the Cycadales, between Indian and European plants during the Mesozoic period. The specimen shown in Text-fig. 30 is of interest as affording an example of a stem from India, which presents a very close agreement with a typical Cycadean trunk. The surface of the trunk (A) is covered with persistent leaf-bases, to which fronds of the type *Ptilophyllum cutchense* were attached; in a section of the stem (B) a large pith is seen to occupy the axial region, and this is surrounded by a zone of secondary wood, which appears to differ from the characteristic wood of existing Cycads in having a more compact structure. The broad parenchymatous medullary-rays form a striking feature in the wood of a recent Cycad, but in the Indian stem, so far as it is possible to examine the structure in detail, the medullary-rays are narrow, and more like those of Conifers than Cycads. The lozenge-shaped areas

[1] Morris, in Grant (40).

external to the axis of the stem (Text-fig. 30, B) represent the sections of petioles, some of which are seen in Fig. 30, A, attached to the stem.



A



B

FIG. 30.—Cycadean stem from India. From a specimen in the British Museum. (Nat. size.)

A. Side-view of the stem clothed with leaf-bases.

B. Transverse section, showing the axis of the stem and numerous leaves.

I hope to describe elsewhere, and in more detail, the structure of this Indian fossil, which is of considerable interest as throwing light on the nature of the stems which bore some of the best known Cycadean fronds. Before describing the English specimens of *Williamsonia pecten*, a brief account may be

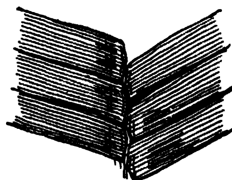


FIG. 31.—'*Pterophyllum rigidum*,' And. (= ? *Williamsonia pecten*), from Steierdorf, Banat. From a specimen in the British Museum. No. 41,438.

given of a few foreign examples, which are of importance as affording evidence in favour of the close similarity or identity of the Yorkshire species and well-known types of fronds from India and Austria.

Text-fig. 31.

The figure represents a small piece of a frond from Steierdorf named by Andrae *Pterophyllum rigidum*;[1] it has the same form as

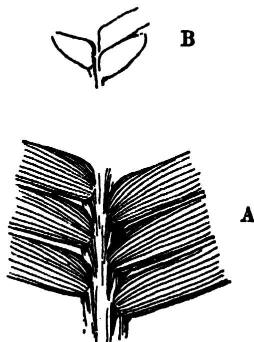


FIG. 32.—'*Ptilophyllum cutchense*,' Morr., from the Rajmahal Hills, India.
B. Basal pinnæ. No. V. 2609*a*.
A. Larger pinnæ (slightly enlarged). No. V. 2609.

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[1] Andrae (53), pl. xi. fig. 42.

the specimens of *Williamsonia pecten* shown in Pl. III. Fig. 4 and in Pl. III. Fig. 6, but there is no indication of any auriculate upper edge at the base of the pinnæ. The veins in Andrae's specimen should have been drawn rather more spreading or oblique to the edge of the lamina in the basal portion of the pinnæ. This plant, I believe, is specifically identical with *Williamsonia pecten.*

Text-fig. 32.

These two drawings represent portions of fronds of the Indian species figured by Morris, Oldham & Morris, and Fiestmantel as *Palæozamia cutchensis* or *Ptilophyllum cutchense* from the Rajmahal Hills. The small basal pinnæ (B) have the upper edge of the base free, and agree precisely in this respect with the small basal pinnæ of *Williamsonia pecten* (cf. Text-fig. 33). Fig. 32A shows the lower portions of a few pinnæ attached to the rachis; each pinna is 1·4 cm. long and 3 mm. broad; the veins are slightly spreading from the base and diverge at the apex, being repeatedly branched as they pass through the lamina. The drawing was made from one of several fronds preserved in unusual perfection in a siliceous rock, where they occur in association with *Dictyozamites.*[1]

There is a close resemblance between the Portuguese frond from Cape Mondego figured by Morris[2] and by Heer[3] respectively as *Otozamites gramineus*, var. *Mundæ*, and *Otozamites angustifolius*, and some of the examples of *Williamsonia pecten*; the original of the drawing given by Morris and copied by Heer is in the British Museum Collection (**41,371**). It is not improbable that the English specimens from the Stonesfield Slate named by Lindley & Hutton *Zamia taxina* are specifically identical with the East Yorkshire plant.

Specimens of *Williamsonia pecten* are abundantly represented in collections of English Jurassic plants, more particularly in the Museums of Scarborough, Cambridge, Newcastle, and Manchester. In the Natural History Museum, Paris, there is an example of this species labelled *Otozamites brevifolius*, from Scarborough, the gift of Dr. Mantell.

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[1] Feistmantel (76), pls. v. and vi., etc.
[2] Morris, in Sharpe (50), pl. xxvi. fig. 7.
[3] Heer (81[1]), pl. ix. fig. 2.

a. Fronds.

48,732. Pl. III. Fig. 1.

The figure shows a small portion of a specimen 11·5 cm. in length. This affords a good illustration of the narrow form of leaf with very small pinnæ, similar to the type figured by Lindley and Hutton as *Pterophyllum pecten.*[1]

V. 3517. Pl. III. Fig. 2.

This example illustrates a somewhat different form of frond, in which the pinnæ are short and relatively broad; the breadth of the specimen, which has a length of 14 cm., is very uniform. At the base the pinnæ measure 4 mm. in length, and those at a higher level have a length of 1·3 cm.; the segments have rounded bases, and are attached along the middle of the upper face of the rachis. A piece of a leaf having much narrower pinnæ occurs in close association with the example shown in the figure.

Upper Shale, Scarborough.

V. 3519. Pl. III. Fig. 3.

The figure represents the apex of a frond 30 cm. long and 5·5 cm. broad; there are several other leaves of this species on the same piece of rock, some of them agreeing with the specimen shown in Fig. 2. These pinnæ (Fig. 3) are fairly broad, and in some of those nearer the lower part of the frond the upper edge of the base is slightly lobed or 'eared.' The apices are acuminate, the lower edge of the pinnæ being more strongly curved towards the tip than the upper. There is a close resemblance between the apex of the frond, as shown in the figure, and that of *Otozamites gramineus*, Phill.,[2] but in Phillips' specimen (now in the Leckenby Collection, Cambridge, No. 216) the pinnæ are of the *Otozamites* type. Several other fronds occur on the same slab with that of Fig. 3. Labelled by Bean *Otopteris lanceolata.*

Lower Shale, Scarborough. *Bowerbank Coll.*

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[1] Lindley & Hutton (34), pl. cii.

[2] Phillips (75), p. 223.

39,284. Pl. III. Figs. 4 and 5.

Fig. 4 represents a small piece of a frond which occurs on a large slab of rock in association with between thirty and forty other examples, of which the pinnæ vary considerably in size and shape. The upper edge of the base of the long and narrow pinnæ shown in Fig. 4 is slightly lobed, but in some of the pinnæ the auriculate base is much more evident. The veins are somewhat spreading at the base, and inclined at an oblique angle to the upper margin of the pinnæ, but their general course is parallel to the long axis of the segments. Cf. *Pterophyllum rigidum* as figured by Andrae,[1] and Text-fig. 31.

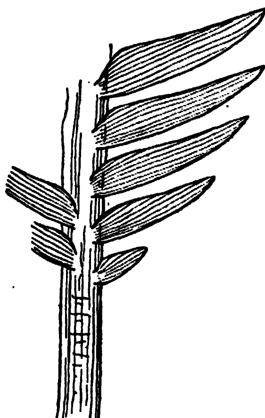


FIG. 33.—The base of a frond of *Williamsonia pecten* (Phill.). No. 13,515. (Nat. size.)

In Fig. 5, Pl. III. we have a form of frond similar to that shown in Fig. 1, but this specimen no doubt represents a young leaf which is not fully expanded, and in which the segments are slightly imbricate in their arrangement, as in the fronds of many recent Cycads. Similar examples of young and narrow fronds, showing an imbricate vernation, may be seen in the Museum of Practical Geology, Jermyn Street, London, and in the Newcastle Collection. Some of the fronds associated with the figured specimens are of the type shown in Fig. 2; others are

[1] Andrae (53), pl. xi. fig. 1.

identical with the type named by Bean *Otopteris lanceolatus*, and by Phillips *Otozamites gracilis*.[1] Cf. Fig. 5 and a drawing of *Ptilophyllum cutchense* given by Feistmantel[2] in pl. xii. fig. 4 of his *Flora of Kach*.

Scarborough. *Bean Coll.*



FIG. 34.—*Williamsonia pecten* (Phill.). V. 3795. (¼ nat. size.)

[1] Phillips (75), p. 224. The original of Phillips' figure is in the Leckenby Collection, Cambridge.

[2] Feistmantel (76).

13,515. Pl. III. Fig. 7.

The base of a petiole, showing the clean-cut surface along which the absciss layer was formed, cutting off the leaf from the persistent portion of the petiole which remained attached to the stem. The broad part of the leaf-stalk immediately above the base presents a characteristic wrinkled appearance.

Text-fig. 34.

V. 3795. Several good fronds with very broad pinnæ of the form shown in Figs. 3 and 6, Pl. III. The larger fronds are so placed on this slab of rock as if converging towards a common point, suggesting their original arrangement when attached to the stem. In one corner of the rock there are portions of much smaller fronds with narrower pinnæ attached to an imperfectly preserved stem. The foot-rule placed against the slab of shale shows the actual size of the fronds. Also fragments of *Brachyphyllum mamillare.*

39,285. Pl. III. Fig. 6.

Part of a frond 8 cm. long. This specimen illustrates the broad type of pinna in which the base does not appear to be auriculate.

Scarborough. *Bean Coll.*

V. 2510. A large slab with several fronds of *W. pecten* and some twigs of *Brachyphyllum mamillare.* Labelled by Bean *Otopteris lanceolata*; this species, instituted by Phillips, is in all probability identical with *O. acuminatus*, and has nothing to do with *W. pecten.*

Lower Sandstone, Scarborough.

V. 2619. A frond 24 cm. long and 1·5 cm. broad, bearing closely crowded, obliquely set, narrow pinnæ. Cf. 2889*a*.

Beckles Coll.

V. 2889*a*. Several good examples of long and narrow fronds with closely set pinnæ; also part of a large frond with pinnæ in which the base is slightly auriculate at its upper edge.

V. 3282. Two large slabs with numerous fronds illustrating the variation in the size and form of the pinnæ; some isolated bracts of flowers also occur in association with the fronds.

V. 3516. In one frond the pinnæ are long and narrow, like those shown in Fig. 4, Pl. III., with spreading veins at the base

and slightly broader and auriculate at the upper edge. Pinnæ 4·5 cm. long. Other fronds with shorter and broader pinnæ, more like those shown in Fig. 2, Pl. III.

V. 3518. Frond similar to that of Fig. 2, Pl. III., associated with others having narrower pinnæ.

V. 3589. Small frond of the type represented in Pl. III. Fig. 1; the basal pinnæ as in Fig. 32, B.

Presented by Dr. F. Corner.

10,312. Similar to Fig. 6, Pl. III.; labelled by Nathorst *Otozamites gracilis.*

40,689. A frond of this species with narrow pinnæ, labelled *Otozamites Goldiæi.*

Other specimens:—**V. 2633** (small form), **V. 2889** (cf. Fig. 5, Pl. III.), **V. 2895, V. 3283, V. 3515** (cf. Fig. 1, Pl. III.), **V. 3590, 12,405, 39,095, 39,286, 40,522, 46,660, 52,568** (cf. Pl. III. Fig. 2), **52,939.**

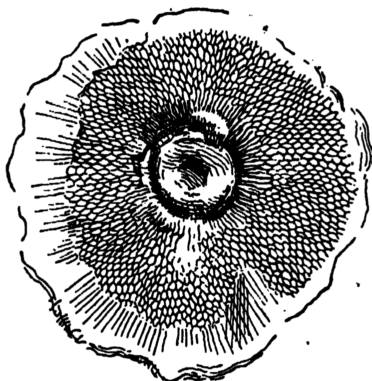


Fig. 35.—*Williamsonia pecten* (Phill.). No. 39,334. (Nat. size.)

b. Flowers.

V. 3284. Pl. III. Fig. 8.

A well-preserved disc showing a prominent central boss and breaking up peripherally into several imperfectly preserved bracts. Several fronds in close association with the disc.

V. 3688. Pl. II. Fig. 7 (slightly enlarged).

A side-view of a disc similar to **V. 3284**, shown in surface-view in Fig. 8, Pl. III. The sides of the central dome-shaped portion are marked by a series of rather prominent ridges, between which occur pairs of slight depressions, indicated in the drawing by black dots representing small patches of carbonaceous matter.

Depth of the disc from the summit of the dome-shaped projecting portion to the end of the bract = 4 cm.

39,334. Text-fig. 35.

The surface-view of the base of a flower; a small raised boss occupies the centre, which is surrounded by a slightly depressed area succeeded by a raised rim; beyond this the surface is covered with a fine reticulum, of which the meshes or polygonal areas become more elongated towards the periphery, where they pass into radiating ridges. Cf. *Williamsonia Carruthersi*, Sew.[1]

39,094. Part of a disc with bracts; the latter shows very clearly the irregular striations similar to those which characterize the bracts in *Williamsonia gigas*, and due, no doubt, to the presence of strands of hypodermal strengthening tissue.

39,296. Two discs and fifteen marginal bracts. Cf. *Williamsonia gigas* (Pl. VIII. Fig. 1). Portions of fronds occur on the same piece of rock.

Genus **ANOMOZAMITES**, Schimper.

[Trait. pal. vég. vol. ii. p. 140, 1870.]

The genus *Anomozamites* may be thus defined:—

Frond comparatively small, linear, or tongue-shaped, usually divided into segments which present a more or less obvious difference in breadth, separate or confluent at the base, attached laterally to the rachis, and never entirely covering the upper face of the frond axis; the segments bluntly rounded or truncate distally; veins simple and parallel, generally at right angles to the rachis.

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[1] Seward (95), pl. x. fig. 4.

The differences between this genus and *Pterophyllum* and *Nilssonia* were discussed in the second volume of the *Wealden Flora*, and need not be considered here.

There is, however, one point of importance as regards the probable systematic position of *Anomozamites*. Nathorst has given a description of some specimens which afford trustworthy evidence of the association of a *Williamsonia* type of flower with *Anomozamites* fronds.[1] The restoration which he gives of the plant indicates a habit different from that of *Williamsonia gigas*; the stem is repeatedly branched dichotomously, and in each fork there is a single flower of *Williamsonia angustifolia*, Nath.,[2] the fronds being of the type *Anomozamites minor* (Brongn.). The specimens on which the restoration is based are in the Palæobotanical Museum, Stockholm; an examination of them a few years ago led me to agree with Professor Nathorst in his interpretation of the habit of the plant. Nathorst's evidence enables us, therefore, to include *Anomozamites* as another member of the Bennettiteæ, closely allied to *Williamsonia gigas* in the form of the reproductive organs, but differing from that type, as also from *Williamsonia pecten*, in the form of the fronds and in the habit of the stem.

The linear shape of the leaf of *Anomozamites* and the unequal segments suggest a comparison with the fronds of *Polypodium irioides*, Lam.; it is of some interest to find that more than one type of Mesozoic Cycadean frond may be fairly closely matched with the leaves of recent ferns. These resemblances, although of no very great value in themselves, are of interest as additional links connecting the Cycadales and Filices, which it is believed represent phyla of the plant kingdom descended from a common stock of remote antiquity.

The resemblance between *Anomozamites* and *Pterophyllum* has led Potonié[3] to unite the two genera, regarding the former as a synonym of the latter; for the present, at least, it is probably the better plan to retain both generic terms.

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[1] Nathorst (88), p. 362.
[2] Nathorst (80^2), pl. viii. figs. 8–10.
[3] Potonié (99), p. 281.

Anomozamites Nilssoni (Phillips).

[Geol. Yorks. p. 147, pl. viii. fig. 4, 1829.]

(Text-fig. 36.)

1829. *Asplenioptcris Nilssoni*, Phillips, Geol. Yorks. p. 147, pl. viii. fig. 4.
1833. *Pterophyllum Nilssoni*, Lindley & Hutton, Foss. Flor. pl. lxvii. fig. 2.
P. minus, ibid. pl. lxvii. fig. 1.
1841. *Pterophyllum Nilssoni*, Morris, Annals, vol. vii. p. 118.
P. minus, ibid.
1848. *Pterophyllum majus*, β var. *minus*, Bronn, Ind. Pal. p. 1056.
1849. *Pterophyllum Nilssoni*, Brongniart, Tableau, p. 106.
P. minus, ibid.
1850. *Pterophyllum minus*, Unger, Gen. spec. plant. foss. p. 292.
1854. *Pterophyllum Nilssoni*, Morris, Brit. Foss. p. 19.
P. minus, ibid.
1864. *Pterophyllum Nilssoni*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
P. minus, ibid. p. 78, pl. ix. fig. 2.
1867. Cf. *Pterophyllum inconstans*, Schenk, Flor. Grenzsch. pl. xxxvii. figs. 5–10.
1870. *Anomozamites Lindleyanus*, Schimper, Trait. pal. vég. vol. ii. p. 141.
1873. *Pterophyllum Nilssoni*, Zigno, Flor. foss. Oolit. vol. ii. p. 22, pl. xxix. fig. 3.
P. minus, ibid. p. 23.
1875. *Pterophyllum Nilssoni*, Phillips, Geol. Yorks. p. 227, pl. viii. fig. 4.
P. minus, ibid. p. 228.
1888. Cf. *Anomozamites minor*, Nathorst, Öfvers. k. Vet. Akad. Förh. 1888, p. 362.
1892. *Anomozamites Lindleyanus*, Fox-Strangways, Tab. Foss. p. 136.

Type-specimen. The type-specimen of Phillips is in the York Museum.

Frond linear or broadly lanceolate; the lamina may be almost entire or divided into distally truncate segments varying considerably in breadth; the apex is obtuse, and the lamina is usually entire at the distal end of the frond. The veins are more or less at right angles to the rachis, and are either simple or dichotomously branched; the branching may occur close to the rachis or in any part of the lamina.

Phillips' figure, which is somewhat crude, represents the type-specimen half the natural size; the veins are indistinct. Some forms of *Anomozamites Nilssoni* exhibit a fairly close agreement with the fronds of *Nilssonia compta*, but the segments of the latter species are usually more oblique to the axis of the frond, and

their apices are more sharply pointed and less truncate than the divisions of the lamina in *Anomozamites Nilssoni*.

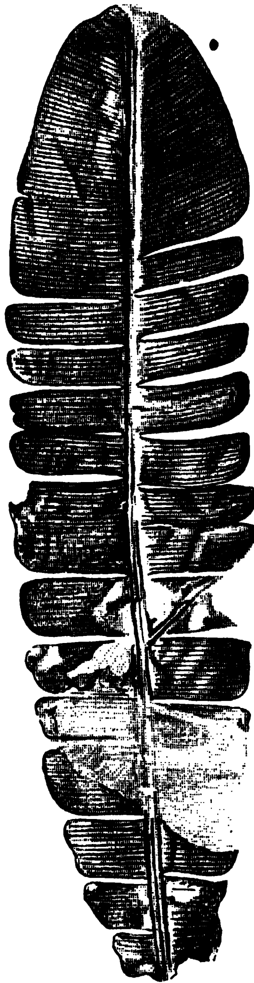


FIG. 36.—*Anomozamites Nilssoni* (Phill.). No. 39,306. (Nat. size.)

There are some good specimens of this species in the Museums of Cambridge, Scarborough, and Manchester. One example in

the Scarborough Collection is unusually perfect; the frond has a length of 12 cm., and in the middle the leaf is 1·9 cm. broad; the veins are very indistinctly shown, as is frequently the case in leaves of this species.

The fronds figured by Nathorst from the Rhætic of Sweden as *Anomozamites gracilis*[1] appear to be very similar to those of *A. Nilssoni*, but they are probably not specifically identical.

39,306. Text-fig. 36.

This specimen illustrates the striking inequality in the segments; at the apex the lamina is entire and obtusely pointed; in the middle and basal portions the lamina is broken up into segments resembling in shape those of *Nilssonia compta*, but differing in their finer texture as well as in their straighter terminations, in the less curved upper edge, and in the venation. The veins in this specimen are not shown quite accurately in the figure; if examined closely they are seen to fork fairly often, as in *Tæniopteris*. Labelled by Bean *Pterophyllum Nilssoni*.

Bean Coll.

39,218. The apex of a leaf preserved in ironstone. Labelled by Bean *Tæniopteris vittata*.

Scarborough.

10,313. A leaf showing a more tapered and pointed apex than in **39,306** (Text-fig. 36). Veins hardly visible.

Gristhorpe Bay. *Mantell Coll.*

39,307. Leaf 19 cm. long; also a smaller leaf on the same piece of shale. The veins are clearly seen, forking either close to their origin or in different parts of the lamina.

13,509. Small and fairly well-preserved frond.

Gristhorpe Bay.

52,568. An impression of a single leaf in sandstone, associated with a very good specimen of *Ginkgo digitata*.

Scarborough, *Bowerbank Coll.*

Other specimens :—**8370, 39,301.**

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[1] Nathorst (78²), pl. xii. figs. 4–12; (78¹), pl. xv. fig. 15.

CYCADALES OF DOUBTFUL AFFINITY.

Genus OTOZAMITES, Braun.

[Braun, in Münster, Beit. Petrefact. Heft vi. p. 36, 1843.]

1. **Otozamites Beani** (Lindley & Hutton).
1a. **Otozamites**, sp., cf. **O. Beani.**
2. **Otozamites Bunburyanus**, Zigno.
3. **Otozamites graphicus** (Leckenby, ex Bean MS.).
4. **Otozamites acuminatus** (Lindley & Hutton).
5. **Otozamites parallelus**, Phillips.
6. **Otozamites obtusus** (L. & H.), var. **ooliticus**, mihi.
7. **Otozamites Feistmanteli**, Zigno.

An account of the history of this genus was given in the second volume of the *Wealden Flora*.[1] We have no evidence as to the nature of the reproductive organs of *Otozamites*, but it may be safely regarded as a Cycadean plant bearing a closer resemblance to ferns in the form and venation of the pinnules than is the case with the majority of recent species of the Cycadaceæ.

1. Otozamites Beani (Lindley & Hutton).

[Foss. Flor. vol. i. pl. xliv. 1832.]

(Pl. I. Figs. 3 and 4; Pl. II. Fig. 3.)

1832. *Cyclopteris Beani*, Lindley & Hutton, Foss. Flor. pl. xliv.
1836. *Adiantites Beani*, Göppert, Foss. Farrn. p. 223.
1838. *Cyclopteris Beani*, Sternberg, Flor. Vorwelt, vii. p. 67.
1848. *Cyclopteris Beani*, Bronn, Ind. Pal. p. 376.
1849. *Otozamites Beani*, Brongniart, Tableau, p. 106.
1850. *Cyclopteris Beani*, Unger, Gen. spec. plant. foss. p. 98.
1854. *Cyclopteris Beani*, Morris, Brit. Foss. p. 7.
1864. *Otopteris mediana*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 78, pl. x. fig. 2.
O. Beani, ibid. p. 76.
1865. *Didymochlæna Beani*, Ettingshausen, Farnk. Jetztwelt, p. 216.
1869. *Otopteris Beani*, Schimper, Trait. pal. vég. vol. i. p. 483.

[1] Seward (95), p. 56.

1870. *Otopteris Beani*, ibid. vol. ii. p. 175.
1875. *Otopteris Beani*, Phillips, Geol. Yorks. p. 220, lign. 45.
O. Beani, Saporta, Pal. Franç. vol. ii. p. 128, pl. xxv. fig. 2.
O. marginatus, ibid. p. 168, pl. cix. fig. 1.
1881. *Otopteris Beani*, Zigno, Flor. foss. Oolit. vol. ii. p. 104.
? *O. Carnossæ*, ibid. p. 95, pl. xxxvii. figs. 3 and 4.
Sphenozamites medianus, ibid. p. 109.
1892. *Otozamites Beani*, Fox-Strangways, Tab. Foss. p. 139.

Type-specimens. Type of *Cyclopteris Beani*, L. & H., in the Scarborough Museum; type of *Otopteris mediana*, Leckenby, in the Woodwardian Museum, Cambridge (No. 235).

Frond pinnate, long, narrow, and of uniform breadth, tapering gradually towards the slender apex. Pinnæ short and broad, varying in shape from broadly oval with bluntly rounded apices to deltoid or suborbicular in the lower part of the frond (Pl. I. Fig. 4), and narrower, longer, and more lanceolate in the distal portion of the frond (Pl. I. Fig. 3). The pinnæ are alternate and in part imbricate, attached by the lower part of the auriculate base to the upper face of the rachis, which is usually hidden by the overlapping auriculate bases of the pinnæ. Veins numerous, repeatedly forked and spreading from the base.

The specimen which Leckenby referred to a distinct species, *Otopteris mediana* (No. 235 in the Leckenby Collection, Cambridge), is, I believe, specifically identical with *O. Beani*, L. & H. In a note written on a specimen in the Leckenby Collection Nathorst also expresses this opinion. A somewhat similar type of *Otozamites* is represented by the Wealden species, *O. Klipsteini* (Dunk.), of which the British Museum possesses a fine series.[1]

This is one of the most striking species among the Yorkshire plants; it is usually placed among the Cycads, but in the absence of any information as to either stems or flowers we have no proof of its Cycadean nature. It is in all probability correctly included in the Cycadales; the form of the leaves recalls that of recent Cycads, but there is no living species of which the pinnæ bear more than a distant resemblance to those of *Otozamites Beani*. It is interesting to find a close agreement between the fronds of this fossil form and those of a recent fern, *Anemia rotundifolia*, Schrad.; the habit of the leaf, the shape and venation

[1] Vide Seward (95), pl. vii.

of the fern, exhibit a greater likeness to *Otozamites Beani* than is presented by any recent Cycad. While believing this Jurassic plant to be a member of the Cycadales, I would draw attention to the fact that the fronds exhibit more marked fern-like characters than are found in recent Cycadean leaves. The Palæozoic Cycadofilices have made us familiar with the union of Filicinean and Cycadean features, and traces of the common origin of the Ferns and Cycads are exhibited by the Mesozoic genus *Bennettites*. In the frond of *Otozamites Beani* we have, I believe, a further indication among Jurassic Cycadean plants of the close relationship of Ferns and Cycads, which is more faintly revealed in the recent species of these two groups. Among recent Cycadean fronds which bear most resemblance to *Otozamites Beani* may be mentioned *Zamia furfuracea*, Ait., and allied forms.

40,568. Pl. II. Fig. 3.

A large slab of shale with two fronds about 20 cm. long, and parts of others. The longest pinna has a length of 3·5 cm. and a breadth of 1·7 cm. The pinnæ are attached to the upper face of the rachis by the lower edge of the base, the lobed upper edge being free and often overlapping the next higher pinna; the veins are well marked, spreading from the point of attachment, and frequently forked. The pinnæ shown in the figure have somewhat more pointed apices than in some of the specimens of this species. Cf. Zigno's figures[1] (pls. xxxv. and xxxvi.) of *O. Molinianus*, Zign.

Lower Shale, Scarborough. *Bean Coll.*

39,214. Pl. I. Fig. 4.

The basal part of a frond, bearing deltoid pinnæ with upward-directed tips; the basal pinnæ are broader in proportion to their length than those shown in Fig. 3. These pinnæ are broader than the corresponding pinnæ in Zigno's specimens of *Otozamites Molinianus*.

Scarborough. *Bean Coll.*

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[1] Zigno (73).

46,634. Pl. I. Fig. 3.

The whole frond, preserved in sandstone, has a length of 21 cm., the apical portion only being shown in the drawing; the lower pinnæ measure 2·5 cm. in length and 1·5 cm. in breadth; they differ slightly from those in **40,568** in having somewhat less pointed distal ends. The apex of the frond bears a fairly close resemblance to that of *Otozamites Klipsteini*, of Wealden age.[1]

Scarborough. *Bowerbank Coll.*

13,500. A good impression in sandstone, showing a petiole 9 cm. long; of the same form as **40,568.** Cf. *Otozamites Canossæ* as figured by Zigno, pl. xxxvii. figs. 3 and 4.

Presented by Dr. Murray.

40,558. A fragment of a frond similar to **40,568.**

1a. Otozamites, sp., cf. O. Beani (L. & H.).

(Text-figs. 37 and 38.)

The portion of a frond shown in Fig. 37 is from the specimen figured by Young & Bird, and now in the Whitby Museum. It

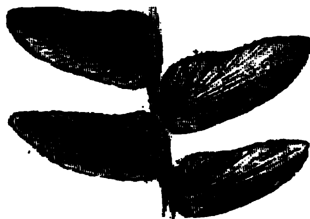


FIG. 37.—*Otozamites*, sp. From a specimen [figured by Young & Bird (28), pl. ii. fig. 8] in the Whitby Museum. (Nat. size.)

is difficult to determine its exact position, but the specimen is interesting as the oldest figured example of a British *Otozamites* frond.

[1] Seward (95), p. 60.

39,278. Text-fig. 38.

This fragment, labelled by Bean *Pachypteris lanceolata*, probably belongs to a frond of *Otozamites Beani.* Compare the terminal portion of a frond figured by Lindley & Hutton.[1]

Oolitic Shale, Saltwick. *Bean Coll.*



Fig. 38.—? *Otozamites*, sp., cf. *O. Beani.* (No. 39,278.)

2. Otozamites Bunburyanus, Zigno.

[Riv. Accad. Sci. Padova, p. 11, 1853.]

(Pl. II. Figs. 4 and 5.)

1853. *Otozamites Bunburyanus*, Zigno, Riv. Accad. Sci. Padova, p. 11.
1864. *Otopteris tenuata*, Leckenby, ex Bean MS., Quart. Journ. Geol. Soc. vol. xx. p. 79, pl. ix. fig. 3.
1868. *Otozamites Bunburyanus*, Zigno, Cicad. foss. Oolit. p. 9, figs. 4 and 5.
1870. *Otozamites Bunburyanus*, Schimper, Trait. pal. vég. vol. ii. p. 174.
1875. *Otozamites tenuatus*, Phillips, Geol. Yorks. p. 221, lign. 46.
O. Bunburyanus, Saporta, Pal. Franç. vol. ii. p. 128, pl. xxv. figs. 3 and 4.
1879. ? *Otozamites Bunburyanus*, Feistmantel, Pal. Ind. pl. vii. figs. 5–8; pl. xvi. fig. 2.
1881. *Otozamites Bunburyanus*, Zigno, Flor. foss. Oolit. vol. ii. p. 102, pl. xxxviii.
1891. *Otozamites Bunburyanus*, Saporta, Pal. Franç. pl. ccxcviii. fig. 1.
1892. *Otozamites tenuatus*, Fox-Strangways, Tab. Foss. p. 140.

Type-specimen. Type of Leckenby's *Otozamites tenuatus* in the Woodwardian Museum, Cambridge (No. 232).

Frond pinnate; pinnæ orbicular, alternate, attached to the upper face of the rachis, which is hidden by the imbricate auriculated

[1] Lindley & Hutton (32), pl. xliv.

upper edges of the bases of the pinnæ. Veins spreading from the bases of the segments, as in *Otozamites Beani*.

Otozamites Bunburyanus agrees in many respects with *O. Beani*, but differs in the smaller size and more rounded or orbicular form of the pinnæ; the long narrow fronds may be compared with those of certain ferns, e.g. *Nephrolepis Duffii*. Some of the Italian specimens referred by Zigno[1] to *Otozamites Trevisani* may be compared with *O. Bunburyanus*. The reproductive organs and stems are unknown, but in all probability this plant represents another example of the combination of Cycadean and Filicinean characters.

The frond figured by Brongniart[2] from a French locality as *Filicites Desnoyersii* and afterwards as *Pecopteris Desnoyersii*[3] may be compared with *Otozamites Bunburyanus*, but the two plants are probably not specifically identical.

The Museums of Cambridge (Leckenby Coll.), York, and Manchester contain interesting specimens of this species.

39,207. Pl. II. Figs. 4 and 5.

The figures represent portions of two fronds. The specimen shows several fronds converging towards one point, suggesting their preservation in a position similar to that which they occupied when attached to the stem. The pinnæ, orbicular or suborbicular in shape, vary but slightly in size in a length of frond of 12 cm. The rachis is broad, and bears the pinnæ obliquely attached to its upper face; in some places the pinnæ are distinctly imbricate, in others separate. The veins are clearly shown spreading from the base and occasionally forked. The fronds vary in breadth from ·6 to ·9 cm.

Lower Shale, Scarborough. *Bean Coll.*

39,207*a*. Portions of six fronds, slightly broader than in **39,207** (Fig. 4).

39,207*b*. Similar to **39,207*a*** and **39,207**; labelled by Bean *Otopteris tenuata*.

40,467. Four specimens from "Scarborough."

[1] Zigno (81), pl. xxxvii. figs. 7 and 8.
[2] Brongniart (24), pl. xix. fig. 1.
[3] Brongniart (28[1]), p. 59; (49), p. 105.

3. Otozamites graphicus (Leckenby, ex Bean MS.).

[Quart. Journ. Geol. Soc. vol. xx. p. 78, pl. viii. fig. 5, 1864.]

(Pl. I. Fig. 2; Pl. II. Fig. 6.)

1824. *Filicites Bucklandi*, var. β, *gallica*, Brongniart, Ann. Sci. nat. vol. iv. p. 422, pl. xix. fig. 3.
1864. *Otopteris graphica*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 78, pl. viii. fig. 5.
1870. *Otozamites graphicus*, Schimper, Trait. pal. vég. vol. ii. p. 170.
1875. *Otozamites graphicus*, Phillips, Geol. Yorks. p. 222, lign. 49.
O. graphicus, Saporta, Pal. Franç. vol. ii. p. 153, pl. ciii. figs. 2 and 3.
O. recurrens, ibid. p. 146, pl. ci. figs. 2 and 3.
Cf. *O. Terquemi*, ibid. pl. xcix. fig. 4.
1881. *Otozamites graphicus*, Zigno, Flor. foss. Oolit. vol. ii. p. 75.
1892. *Otozamites graphicus*, Fox-Strangways, Tab. Foss. p. 139.

Type-specimen. Leckenby Collection, Cambridge (No. 215).

Frond pinnate; pinnæ more or less falcate, attached alternately to the upper surface of the rachis, characterized by the strongly auriculate upper edge of the base; veins spreading in the basal portion of the segments and slightly oblique to the upper edge of the rest of the lamina; apices acuminate and directed upwards.

The species *Otopteris graphica* is mentioned by Bronn[1] in 1848 and by Morris[2] in 1854, but these authors refer to the specific name instituted by Bean in manuscript, without publication; the first description and illustration of the species under Bean's name is in Leckenby's paper of 1864. The fragment figured by Brongniart as *Filicites Bucklandi*, var. *gallica*, from Mamers, of Bathonian age, is probably specifically identical with the more perfect frond figured by Leckenby; this view is adopted by Saporta and Schimper. Considering the fragmentary nature of Brongniart's specimen it is safer to regard Leckenby's specimen as the type of the species and to retain the name originally proposed by Bean.

Some of the Rhætic fronds figured by Schenk as *Otopteris Bucklandi*[3] very closely resemble *Otozamites graphicus*, and afford connecting links between that species and *O. obtusus*.

[1] Bronn (48), p. 887.
[2] Morris (54), p. 14.
[3] E.g. Schenk (67), pl. xxxiv. figs. 3 and 6.

A specimen in the Scarborough Museum, which is no doubt identical with this species, has been named by Richards[1] *Otozamites Phillipsii*, but no description of the species has been published. Good examples are contained in the collections at Whitby and Cambridge. Specimens of *Otozamites graphicus* are occasionally met with labelled *O. acuminatus*, but the falcate form of the pinnæ and their more regular oblique attachment to the rachis afford distinguishing features.

40,515. Pl. I. Fig. 2.

A portion of a frond 11 cm. in length. The figure shows the upwardly directed and pointed tips, the strongly falcate form, and the well-marked lobes and spreading veins which characterize the pinnæ of this species.

Scarborough. *Bowerbank Coll.*

40,690. Pl. II. Fig. 6.

This smaller example is in all probability specifically identical with the larger frond (**40,515**); the comparatively short, more falcate, and pointed pinnæ constitute a difference between this specimen and the frond of similar size referred to *Otozamites obtusus*, var. *ooliticus*, as represented in Pl. II. Fig. 2.

Oolitic Shale, Gristhorpe Bay. *Presented by Dr. Murray.*

4. Otozamites acuminatus (Lindley & Hutton).

[Fossil Flora, vol. ii. pl. cxxxii. 1834.]

(Pl. II. Fig. 1; Pl. VI. Fig. 1.)

1828. *Zamia Mantelli*, Brongniart, Prodrome, p. 94.
Z. Youngii, ibid.
1829. *Cycadites latifolius*, Phillips, Geol. Yorks. p. 154, pl. x. fig. 1.
C. lanceolatus, ibid. p. 154, pl. x. fig. 3.
1834. *Otopteris acuminata* (pars), Lindley & Hutton, Foss. Flor. pl. cxxxii. (the lower figure only).
1836. *Odontopteris acuminata*, Göppert, Foss. Farrn. p. 211.
? *O. undulata*, ibid. p. 209.
1837. *Otopteris acuminata*, var. *brevifolia*, ibid. pl. ccviii.

[1] Synopsis of the British Fossil Cycadaceous Leaves, p. 5. (Private proof, Edinburgh, 1884.)

1838. *Cyclopteris acuminata*, Sternberg, Flor. Vorwelt, fasc. vii. p. 133.
Zamites undulatus, ibid. p. 197.
1848. *Odontopteris acuminata*, Bronn, Ind. Pal. p. 837.
Zamites Youngii, ibid. p. 1379.
Z. Mantelli, ibid. p. 1378.
1849. *Otozamites Youngii*, Brongniart, Tableau, p. 106.
O. acuminatus, ibid.
? *Zamites undulatus*, ibid.
1850. *Otozamites acuminata*, Unger, Gen. spec. plant. foss. p. 88.
Zamites lanceolatus, ibid. p. 282.
1854. *Otozamites acuminata*, Morris, Brit. Foss. p. 14.
1864. *Otopteris acuminata*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
O. lanceolata, ibid.
1868. ? *Zamites Bechei*, Eichwald, Leth. Ross. pl. ii. fig. 9.
1869. *Otopteris accuminata*, Schimper, Trait. pal. vég. vol. i. p. 484.
1870. *Otozamites acuminatus*, ibid. vol. ii. p. 176.
O. intermedius, ibid.
1875. *Otopteris acuminatus*, Phillips, Geol. Yorks. p. 223, lign. 50.
O. latifolius, ibid. p. 224, pl. x. fig. 1.
O. lanceolatus, ibid. p. 223, pl. x. fig. 3.
Zamites distractus, Saporta, Pal. Franç. vol. ii. p. 115; pl. xciii. figs. 4 and 5.
Z. acerosus, ibid. pl. lxxxvi.
Otozamites Youngii, ibid. p. 128, pl. xcvi. fig. 1.
1881. *Otozamites Youngii*, Zigno, Flor. foss. Oolit. vol. ii. p. 79.
O. acuminata, ibid. p. 80.
O. intermedius, ibid. p. 82.
? *Sphenozamites undulatus*, ibid. p. 108.
1892. *Otozamites acuminatus*, Fox-Strangways, Tab. Foss. p. 139.
O. latifolius, ibid.
O. lanceolatus, ibid.

Type-specimen. Type of Lindley & Hutton, Scarborough Museum. Type of *Otozamites latifolius*, York Museum.

Frond pinnate, of similar form to that of *Williamsonia gigas*, from which it differs in the more gradually tapered and acuminate pinnæ, and in the wider angle at which the segments are attached to the rachis. The apical pinnæ are narrow, linear in form, while the basal pinnæ are shorter and broader, and more or less ovate, with an acuminate apex, attached to the rachis at a slightly obtuse angle.

It is convenient to designate certain forms of this species in which the pinnæ are short and tapering distally to an acuminate apex (e.g. Pl. II. Fig. 1) *O. acuminatus*, var. *brevifolius*, and others with broader pinnæ *O. acuminatus*, var. *latifolius*. The former name, var. *brevifolius*, was used by Lindley & Hutton for

fronds with shorter pinnæ; the latter term was adopted by Phillips as a specific name. The type-specimen of Phillips' species is in the York Museum, and consists of an imperfectly preserved portion of a frond which cannot be satisfactorily defined as a species distinct from *O. acuminatus*, but is, I believe, identical with this species. The drawing given by Phillips is by no means accurate; the veins in the pinnæ are numerous, and not as represented in the figure.

This species bears a close resemblance to *Otozamites Beani*, and the two types of frond may be almost connected by transitional forms; the longer and narrower acuminate pinnæ of *Otozamites acuminatus* afford the most convenient distinguishing feature. Some fronds of *Williamsonia gigas* also present a strong likeness to those of *Otozamites acuminatus*; their resemblance affords one of several instances illustrating the difficulty of drawing any satisfactory distinction between the *Zamites* and *Otozamites* type of pinnæ. In *Otozamites acuminatus* the lower pinnæ are shorter and broader than in *Williamsonia gigas*, and are frequently attached to the basal portion of the rachis at a slightly obtuse angle. Good specimens of the species occur in the Museums of Scarborough, Whitby, and Newcastle, also in the Museum of Practical Geology, Jermyn Street, London, and in other collections.

39,203. Pl. VI. Fig. 1.

Part of a specimen 15 cm. long; labelled by Bean *Otozamites acuminatus*. The pinnæ are attached to the rachis at a wide angle, and are shorter, broader, and more acuminately pointed than in *Williamsonia gigas*. The bases of the pinnæ, as shown in the figure, are rounded at the corners and are hardly typical of *Otozamites*, but some of the smaller pinnæ of this species are more definitely lobed and conform more nearly with the recognized character of the genus. Cf. *Zamites Moreaui*, Sap.[1]

Scarborough. *Bean Coll.*

40,468. Pl. II. Fig. 1.

The total length of the specimen is 9·5 cm. This specimen probably represents the basal portion of a frond, as we know from

[1] Saporta (75), pls. xiv. and xv.

larger examples that the basal pinnæ are very short in comparison with those in the middle of the frond. The upper corner of the bases of the pinnæ is slightly auriculate. This example may be referred to as *O. acuminatus*, var. *brevifolius*.

39,199. A frond showing shorter basal pinnæ similar to those of **40,468** (Pl. II. Fig. 1) and longer pinnæ similar to those of **39,203** (Pl. VI. Fig. 1). This frond measures 28 cm. in length.
Bean Coll.

39,202. A specimen 24 cm. long, with shorter and relatively broader pinnæ than **39,199.** Labelled by Bean *Otopteris acuminata.* This should also be referred to *Otozamites acuminatus*, var. *brevifolius.*
Bean Coll.

V. 3943. Probably a badly preserved fragment of this species.

5. Otozamites parallelus, Phillips.

[Geol. Yorks. p. 221, lign. 47, 1875.]

1853. ? *Otozamites mattiellianus*, Zigno, Riv. Accad. Sci. Padova, p. 10.
1875. *Otozamites parallelus*, Phillips, Geol. Yorks. p. 221, lign. 47.
1881. *Otozamites Nathorsti*, Zigno, Flor. foss. Oolit. vol. ii. p. 93, pl. xxxvii. fig. 1.
? *Ptilophyllum grandifolium*, ibid. p. 62, pl. xxxii. figs. 3 and 4.
Otozamites mattiellianus, ibid. p. 70, pl. xxxiv. figs. 9 and 10.
1892. *Otozamites parallelus*, Fox-Strangways, Tab. Foss. p. 139.

Frond pinnate; pinnæ short and comparatively broad, attached to the upper face of the rachis at a wide angle, the base is slightly auriculate at the upper edge; veins somewhat spreading at the base, but approximately parallel to the edge of the lamina through the greater part of their course; apex of the pinnæ obtuse.

This species was defined by Phillips as follows:—"Frond very long, narrow, composed of many oval, slightly obtuse leaves, two or three times as long as broad, set perpendicular to the rachis; venation radiating from the proximal part of the base of the leaf, furcate, and dividing to about forty venules towards the edge."

I have adopted Phillips' specific name for a few specimens of *Otozamites* fronds represented in several English collections, which agree very closely with some of the fronds figured by Zigno from Italy, and also closely resemble in the form of their pinnæ the

type shown in woodcut 47 of the *Geology of Yorkshire*. It is questionable whether the wiser plan would be to make use of one of Zigno's specific names, but as I feel practically no doubt as to the specific identity of the specimens referred to *O. parallelus* and the type-specimen of Phillips' species, I have revived the name instituted by this author. Some of the smaller forms of Zigno's species *Otozamites Molinianus*[1] are, to some extent, intermediate in form between *O. parallelus* and *O. Feistmanteli*.

Otozamites parallelus may be compared also with a similar but probably not identical species, *Nilssonia pterophylloides*, described by Yokoyama from Japan.[2]

This type of frond is represented by a single specimen in the National Collection. The best examples are in the Leckenby Collection, Cambridge (Nos. 218, 219), and in the Scarborough Museum.

51,410. A small specimen 10 cm. long and 2·6 cm. broad, specifically identical with some larger examples in the Leckenby Collection, Cambridge. The pinnæ are short and comparatively broad, and the upper edge of the base is slightly eared. Labelled *Otozamites obtusus*.

6. Otozamites obtusus (Lindley & Hutton), var. ooliticus, mihi.

[*O. obtusus*: Foss. Flor. pl. cxxviii. 1834.]

(Pl. I. Fig. 1; Pl. II. Fig. 2.)

1825. *Filicites Bechii*, Brongniart, Ann. Sci. nat. vol. iv. pl. xix. fig. 4.
1828. *Zamites Bucklandi*, Brongniart, Prodrome, p. 199.
Z. Bechii, ibid.
1834. *Otopteris obtusus*, Lindley & Hutton, Foss. Flor. pl. cxxviii.
1843. *Zamites brevifolius*, Braun, in Münster, pl. xiii. fig. 13.
1849. *Otozamites obtusus*, Brongniart, Tableau, p. 104.
O. Bucklandi, ibid. p. 105.
1864. *Otopteris obtusa*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
1867. *Otopteris Bucklandi*, Schenk, Grenzsch. pls. xxxiii. and xxxiv.
1870. *Otozamites obtusus*, Schimper, Trait. pal. vég. vol. ii. p. 171.
1868. Cf. *Zamites approximatus*, Eichwald, Leth. Ross. pl. ii. fig. 8.

[1] Zigno (52), pl. xxxv.
[2] Yokoyama (94), p. 228, pl. xxii. figs. 8–10; pl. xxv. fig. 7.

1875. *Otopteris obtusa*, Phillips, Geol. Yorks. lign. 48, p. 222.
Cf. *Otozamites pterophylloides*, Saporta, Pal. Franç. p. 157, pls. xxxiv., xxxvii., and xxxviii. fig. 1.
Cf. *O. Hennoquei*, ibid. pl. c. fig. 1.
1881. *Otozamites vicetinus*, Zigno, Flor. foss. Oolit. vol. ii. p. 69, pl. xxxiii. figs. 3 and 4.
1892. *Otozamites obtusus*, Fox-Strangways, Tab. Foss. p. 139.

Type-specimen. The original of pl. cxxviii. of the *Fossil Flora* is in the Oxford Museum.

The Inferior Oolite form differs slightly from the type-specimen of *Otozamites obtusus* (L. & H.)[1] in the pinnæ having slightly more acuminate apices, and in the lower margin of the pinnæ being somewhat less abruptly curved upwards. (Cf. the drawing given by Lindley & Hutton, and Pl. I. Fig. 1 and Pl. II. Fig. 2 of this Catalogue.)

The form of Cycadean frond represented by the type-specimen of *Otozamites obtusus* from the Lias near Axminster, and now in the Oxford Museum, is one which is widely spread in Rhætic, Liassic, and Oolitic strata. There are several fronds described from these horizons by various authors under different specific names, which it is practically impossible to separate from one another by any really distinctive features of taxonomic value. To avoid the danger of artificial distinction, suggested by the application of specific names to fronds which agree with one another in their general form, but differ in slight variations in the form of the pinnæ, apices, and other inconstant and unimportant characters, I propose to use the designation *Otozamites obtusus* in a wide sense, as denoting a type of frond represented by examples hitherto considered as distinct species. The very strong likeness between the 'species' which centre round *Otozamites obtusus* is well illustrated by the lists of synonyms given by different authors. There is a want of unanimity in the interpretation of the extremely slight differences which may be detected in comparing the fronds from Rhætic, Liassic, and Oolitic horizons, demonstrating the absence of any satisfactory distinctive features worthy of specific distinction. The differences between young and old fronds of

[1] There are several good examples of the Lias form, identical with the type-specimen of Lindley & Hutton, in the British Museum; e.g., Nos. 39,059, 40,692, 47,045, etc.

one and the same plant are, indeed, greater than between some of the so-called species of this type of frond. It is wiser to admit that we cannot hope to accurately separate species by such fine distinctions as have been discovered in the form of the pinnæ of fronds from different localities. A slight difference in geological age is often responsible for the undue importance attached to almost imperceptible distinctions, which are raised to the rank of specific characters.

In the list of synonyms I have included such forms as agree most nearly with *Otozamites obtusus*, L. & H.; it is not meant to imply that the several 'species' are identical, but that they are all characterized by the possession of fronds conforming in the main to one type; such small differences as may be recognized are not considered sufficient to warrant their use as specific characters. It may be convenient to retain some, at least, of the specific names as varietal or 'form' designations. The Inferior Oolite fronds which Phillips spoke of as *Otozamites obtusus* [1] may be spoken of as *Otozamites obtusus* (L. & H.), var. *ooliticus*, in order to draw a distinction between the Inferior Oolite fronds and the closely allied, but not absolutely identical, type of Liassic age.

There are some very good examples of this type of *Otozamites* in the York Museum, one of which, labelled by Bean *Otopteris graphica*, has a length of 17 cm. The pinnæ have pointed apices, and the upper edge of the base is distinctly auriculate.

39,201. Pl. I. Fig. 1.

This frond, of which a few pinnæ are represented in the drawing, measures 40 cm. in length, and is one of the most beautiful examples of a fossil Cycadean leaf in the Museum Collection. The portion figured is a little above the middle of the whole frond. The pinnæ vary very slightly in size (about 5 cm. long and 1 cm. broad) throughout the length of the frond; they are obliquely attached to the upper face of the rachis, and the upper edge of the base is prominently eared. The apices are obtusely pointed; the upper edge of the lower pinnæ is somewhat more falcate than in those shown in Fig. 1, but the more strongly curved and sharply pointed pinnæ of *Otozamites*

[1] Phillips (75), p. 222.

graphicus are readily distinguished from those of the present species. Labelled by Bean *Otopteris graphica*.
Lower Shale, Scarborough. *Bean Coll.*

14,010. Pl. II. Fig. 2.

A younger frond than **39,201** (Fig. 1, Pl. I.), showing the overlapping of the pinnæ, which have the eared base and obtusely pointed tips, as in the larger example.
Gristhorpe Bay. *Presented by Dr. Murray.*

7. Otozamites Feistmanteli, Zigno.

[Flor. foss. Oolit. vol. ii. p. 90, pl. xxxiv. figs. 6–8, 1881.]

1845. Cf. *Zamites Mandelslohi*, Kurr, Foss. Flor. Württ. p. 10, pl. i. fig. 3.
1853. Cf. *Otozamites Massalongianus*, Zigno, Riv. Accad. Sci. Padova, p. 10.
1863. ? *Palæozamia bengalensis*, Oldham & Morris, Pal. Ind. vol. i. pl. xiv.
1881. *Otozamites Feistmanteli*, Zigno, Flor. foss. Oolit. vol. ii. p. 90, pl. xxxiv. figs. 6–8.
Cf. *O. Massalongianus*, ibid. p. 86, pl. xxxiv. figs. 1–4.
1890. Cf. *Otozamites Mandelslohi*, Feistmantel, Foss. Flor. Australia, pl. xxviii. fig. 9.
1895. Cf. *Otozamites crassifolius*, Lignier, Vég. foss. Normandie, p. 141.

Frond narrow, linear; pinnæ short and broad, attached to the upper face of the rachis by a broad base, of which the upper corner is slightly auriculate; the apex is bluntly rounded, the tip being directed upwards. Venation of the *Otozamites* type.

In the Museums of York and Leeds there are a few fairly large and well-preserved fronds which I regard as specifically identical with certain Italian specimens named by Zigno *Otozamites Feistmanteli*; they are characterized by their long and narrow form, comparable to *O. Bunburyanus*, and short and broad pinnæ. The pinnæ differ from those of the latter species in being longer and less orbicular in shape; but some fronds referred by Zigno to *Otozamites Trevisani*[1] furnish an example of a form more or less intermediate between *O. Feistmanteli* and *O. Bunburyanus*. It is not improbable that another Italian frond named by Zigno

[1] Zigno (81), pl. xxxvii. figs. 7 and 8.

O. Massalongianus[1] is specifically identical with *O. Feistmanteli*, but the latter name has been adopted on account of the more striking agreement of the specimens so named by Zigno with the English examples.

Some of the smaller fronds of *Otozamites Molinianus*[2] may be compared also with *O. Feistmanteli*, as well as with *O. parallelus*. One or two of the specimens from Italy figured as *Otozamites veronensis*, Zigno,[3] are also very similar to *O. Feistmanteli*.

The Indian Cycadean leaves named by Oldham & Morris *Palæozamia bengalensis*[4] are practically indistinguishable from *O. Feistmanteli*.

The frond described by Kurr from a German locality as *Zamites Mandelslohi*[5] is closely allied to, if not identical with, *Otozamites Feistmanteli*. Another example of a similar type of leaf is afforded by *O. Reglei* as figured by Saporta.[6] These two species are compared by Lignier with a similar type of *Otozamites* (*O. crassifolius*), which he has described from a Lias locality in Normandy.[7]

The York specimen of *Otozamites Feistmanteli* has a length of 22 cm.; the pinnæ vary in length from 8 mm. to 1·4 cm., having an average breadth of 6 mm. The example in the Leeds Museum represents a smaller frond, bearing pinnæ about 8 mm. long.

V. 3683. This is the only specimen in the British Museum which appears to be identical with Zigno's species; it is 6 cm. long and 1 cm. in breadth, bearing short, broad, and closely set pinnæ.

[1] Zigno (52), p. 10; (81), p. 86, pl. xxxiv. figs. 1–5.
[2] Zigno (52), p. 10; (81), p. 92, pl. xxxv. figs. 1–3; pl. xxxvi. figs. 1–5.
[3] Zigno (81), pl. xxxiii. fig. 7.
[4] Oldham & Morris (63), pl. xiv.
[5] Kurr (45), p. 10, pl. i. fig. 3.
[6] Saporta (75), pl. cix.
[7] Lignier (95), p. 141.

Genus **NILSSONIA**, Brongniart.

[Ann. Sci. nat. vol. iv. p. 200, 1825.]

The characteristics of this genus have already been discussed at length in the second volume of the *Wealden Flora*,[1] and need not be recapitulated.

1. **Nilssonia compta** (Phillips).
2. **Nilssonia mediana** (Leckenby, ex Bean MS.).
3. **Nilssonia tenuinervis**, Nathorst.

1. **Nilssonia compta** (Phillips).

[Geol. Yorks. p. 148, pl. vii. fig. 20.]

(Pl. IV. Fig. 5; Text-figs. 39 and 40.)

1828. *Pterophyllum Williamsonis*, Brongniart, Prodrome, p. 95.
1829. *Cycadites comptus*, Phillips, Geol. Yorks. p. 148, pl. vii. fig. 20.
1833. *Pterophyllum comptum*, Lindley & Hutton, Foss. Flor. vol. i. pl. lxvi.
1841. *Pterophyllum comptum*, Morris, Annals, vol. vii. p. 118.
1848. *Nilssonia compta*, Bronn, Ind. Pal. p. 812.
1849. *Nilssonia compta*, Brongniart, Tableau, p. 106.
1850. *Nilssonia compta*, Unger, Gen. spec. plant. foss. p. 295.
1854. *Pterophyllum comptum*, Morris, Brit. Foss. p. 19.
1856. Cf. *Danæites Heeri*, Zigno, Flor. foss. Oolit. vol. i. pl. xxv. figs. 1–4.
1863. Cf. *Pterophyllum princeps*, Oldham & Morris, Pal. Ind. p. 23, pls. x.–xiii.
1864. *Pterophyllum comptum*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77, pl. ix. fig. 1.
1867. Cf. *Nilssonia polymorpha*, Schenk, Flor. Grenz. pls. xxix.–xxxi.
1870. *Pterozamites comptus*, Schimper, Trait. pal. vég. vol. ii. p. 147.
1873. *Pterophyllum comptum*, Zigno, Flor. foss. Oolit. vol. ii. p. 20.
1875. *Pterophyllum comptum*, Phillips, Geol. Yorks. p. 227, pl. vii. fig. 20.
1877. ? *Anomozamites Schmidtii*, Heer (77[2]), pls. xxiii. and xxiv.
1878. Cf. *Nilssonia polymorpha*, Nathorst, Flor. Bjuf, p. 72, pl. xv. figs. 3–5.
1883. *Nilssonia compta*, Schenk, in Richthofen's China, p. 262, pl. liv. fig. 2.

[1] Seward (95), p. 50.

1887. Cf. *Nilssonia polymorpha*, Schenk, Foss. Pflanz. Albourskette, p. 7; pl. i. fig. 3; pl. v. fig. 22.
? *N. compta*, ibid. pl. viii. fig. 47.
1892. *Nilssonia compta*, Fox-Strangways, Tab. Foss. p. 139.

Frond broadly linear, varying considerably in size and in the depth and number of the segments. The lamina is dissected up to the central midrib or rachis into truncate segments of unequal breadth, traversed by several parallel veins both simple and forked; the lamina is continuous over the rachis of the frond, and the segments are not laterally attached as in *Pterophyllum*.

Brongniart includes in his *Prodrome*, under the name *Pterophyllum Williamsonis*, a species from the Lower Oolite in the list of examples of *Pterophyllum*, but in the *Tableau* this name occurs as a synonym of *Nilssonia compta*. Phillips' figure of this species in the *Geology of the Yorkshire Coast* represents a portion of a frond one-half natural size. An earlier drawing given by Young & Bird of a specimen which is now in the Whitby Museum (No. 2381) illustrates somewhat crudely the characteristic features of the same type of leaf.

Nilssonia compta is one of the most abundant species in the Inferior Oolite flora, and is usually represented by several specimens in museum collections. Without attempting a comparative account of the various fossils of Mesozoic age which agree more or less closely with Phillips' species, attention may be drawn to the large leaves figured by Fontaine from the Potomac plant-beds under the name *Platypterigium densinerve*.[1] An examination of a few specimens of this species in the Washington Geological Museum led me to regard the plant as probably a *Nilssonia*.

The large and broad fronds from the Rajmahal Hills of India, figured by Oldham & Morris[2] and by Feistmantel[3] as *Pterophyllum princeps*, bear a close resemblance to the largest examples of *Nilssonia compta*; it is not clear from the illustrations if the segments of the lamina are laterally attached as in *Pterophyllum*, or if the median portion of the frond is incomplete and presents a deceptive resemblance to that genus. In specimens of *Nilssonia compta* one occasionally sees the rachis represented by a fairly

[1] Fontaine (89), pl. xxx. fig. 8; pls. xxxi.–xxxv.
[2] Oldham & Morris (63), pls. x.–xiii.
[3] Feistmantel (77), pl. xlvii.

broad shallow groove, which might suggest the lateral attachment of the lamina characteristic of *Pterophyllum* fronds.

The largest examples I have met with are in the Whitby Museum, some of which have a length of over 40 cm. and a breadth of 9 cm. (vide Text-fig. 40). A large frond, with narrow segments, 31 cm. in length, may be seen in the Scarborough Museum. Good specimens are represented also in the Leckenby Collection, Cambridge, the Museum of Practical Geology, London, and elsewhere. A Scarborough specimen in the Natural History Museum, Paris, bears the name *Nilssonia Williamsonis*, the original specific designation proposed by Brongniart.

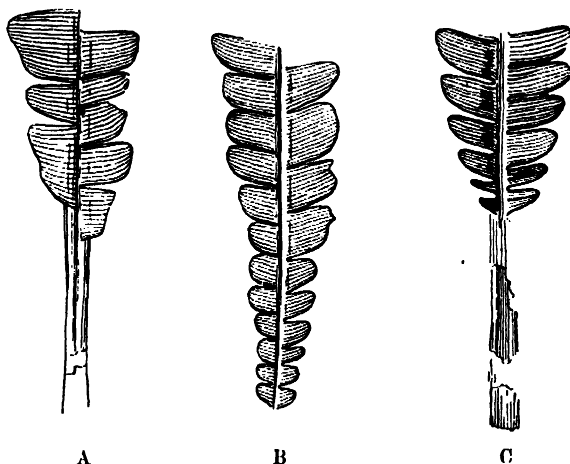


FIG. 39.—*Nilssonia compta* (Phill.).

A and B. No. V. 2894. C. No. 40,469. (Nat. size.)

Nilssonia compta, characteristic of the Inferior Oolite vegetation, appears to be practically identical with some, at least, of the fronds of Rhætic age described by Schenk,[1] Nathorst,[2] and others as *N. polymorpha*; this close resemblance affords one of many instances of the marked agreement between the Rhætic and Inferior Oolite floras.

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[1] Schenk (67).
[2] Nathorst (78[1]), (78[2]).

39,292. Pl. IV. Fig. 5.

A frond 28 cm. long and 6·2 cm. broad at the widest part; labelled by Bean *Pterophyllum comptum.* This unusually good specimen demonstrates the *Nilssonia* character of the species, the typical form of the segments, and the general habit of the frond. The parallel veins are well marked as prominent ridges on the surface of the segments.

Gristhorpe Bay. *Bean Coll.*

V. 2894. Text-figs. 39A and B.

Good examples of fronds of medium width. In one of the specimens (Fig. A) the manner of attachment and form of the basal segments are clearly shown; they extend to the middle of the upper face of the rachis, and are not attached to the edge as in *Pterophyllum.* In Fig. B the basal segments are much shorter and smaller than in the example illustrated in Fig. A. These two figures afford good examples of the variation in the basal portion of fronds of the same species. The longest frond measures 18 cm. in length.

Near Scarborough. *Beckles Coll.*

40,469. Text-fig. 39C.

Another basal portion of a frond, showing the broad petiole and the form of the lowest segments. The segments of this frond have very prominent veins as broad ribs, with occasionally much finer veins between. The prominence of the ribs is no doubt due to the presence of bands of thick-walled hypoderm, which with the vascular bundles probably constituted I-shaped strengthening girders stretching across the lamina.

Text-fig. 40.

Part of an unusually large frond in the Whitby Museum. Owing to the imperfect state of preservation of the median portion, the segments do not extend so far over the upper face of the rachis as in the more perfect specimens. The whole frond measures more than 40 cm. in length, and has a breadth of 9 cm. Cf. Schenk's figures of *Nilssonia polymorpha*; also the fronds from India described by Oldham & Morris as *Pterophyllum princeps.*

* 39,305. A long and narrow frond, associated with *Tæniopteris vittata* and other plants.
Near Scarborough. *Bean Coll.*

Other specimens:—V. 2516 (short and basal segments), V. 2517, V. 3520, 10,311 (a good example from Gristhorpe Bay), 12,398, 13,510, 13,513, 40,469*a*, 52,582.



Fig. 40.—*Nilssonia compta* (Phill.).
A small portion of a large specimen in the Whitby Museum (drawn by M. Seward). (Nat. size.)

2. Nilssonia mediana (Leckenby, ex Bean MS.).

[Quart. Journ. Geol. Soc. vol. xx. p. 77, pl. viii. fig. 3, 1864.]

(Pl. IV. Figs. 1–4.)

1829. *Cycadites tenuicaulis*, Phillips, Geol. Yorks. p. 148, pl. vii. fig. 19.
1841. *Pterophyllum tenuicaule*, Morris, Annals, vol. vii. p. 119.
1848. *Pterophyllum tenuicaule*, Bronn, Ind. Pal. p. 1057.
1849. *Pterophyllum tenuicaule*, Brongniart, Tableau, p. 106.

1850. *Pterophyllum tenuicaule*, Unger, Gen. spec. plant. foss. p. 281.
1854. *Pterophyllum tenuicaule*, Morris, Brit. Foss. p. 19.
1864. *Pterophyllum medianum*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77, pl. viii. fig. 3.
1864. *Pterophyllum tenuicaule*, ibid. p. 76.
P. angustifolium, ibid. p. 77, pl. viii. fig. 2.
1870. *Dioonites medianus*, Schimper, Trait. pal. vég. vol. ii. p. 148.
D. angustifolius, ibid.
1873. *Pterophyllum medianum*, Zigno, Flor. foss. Oolit. vol. ii. p. 24, pl. xxix. fig. 4.
P. angustifolium, ibid. p. 26.
P. tenuicaule, ibid.
1875. *Pterophyllum medianum*, Phillips, Geol. Yorks. p. 226, lign. 55.
P. tenuicaule, ibid. p. 227, pl. vii. fig. 19.
P. angustifolium, ibid. p. 227, lign. 56.
1892. *Nilssonia mediana*, Fox-Strangways, Tab. Foss. p. 139.
N. angustifolia, ibid. p. 138.
N. tenuicaulis, ibid. p. 139.

Type-specimens. The type-specimens of *Pterophyllum medianum*, Leckenby, ex Bean MS., and of *P. angustifolium*, Leck., ex Bean MS., are in the Leckenby Collection, Cambridge (Nos. 278, 275).

Frond broadly linear; the lamina is divided into numerous linear segments of unequal breadth traversed by several parallel veins. This species agrees closely in habit with *Nilssonia compta*, but differs in the narrower leaf-segments and in their more acuminate and less truncate apices. The veins are somewhat less prominent in *Nilssonia mediana*, and the lamina is thinner and not so stout as in *N. compta*.

The specimen figured by Phillips in 1829 as *Cycadites tenuicaulis* from the middle shale of Gristhorpe is defined as follows in the third edition of the *Geology of Yorkshire*:—"Frond lanceolate, ample, with a slender rachis; leaflets perpendicular to the rachis, unequal, ending obtusely, approximate at the base; venation parallel, delicate."[1]

In 1864 Leckenby described two species of Yorkshire Oolite plants under the names *Pterophyllum medianum* and *P. angustifolium*; the type-specimens of these species are, I believe, indistinguishable specifically from the plant named by Phillips *Cycadites tenuicaulis*. According to the strict rules of priority Phillips' term should be

[1] Phillips (75), p. 227.

retained, but as we possess the type-specimens of Leckenby his specific designation *mediana* may be used in preference to the older term.

Some of the best examples of *Nilssonia mediana*, other than those in the British Museum, are in the Leckenby Collection, Cambridge.

39,293. Pl. IV. Fig. 1.

This frond measures 20 cm. in length, and illustrates the larger form of the species. The segments vary considerably in breadth; they are distinctly broadened at the base, and longer in proportion to their width than in *Nilssonia compta.* The simple parallel veins are clearly preserved.

39,290. Pl. IV. Fig. 2.

Frond 18 cm. long, with very narrow segments, about 4 cm. long and 3–6 mm. broad; more acutely pointed than in **39,293.** The rachis is represented by a shallow groove. This type of frond was named by Leckenby *Pterophyllum angustifolium*, and the specimen is so labelled by Bean; a comparison of several specimens in the Leckenby and British Museum Collections leads me to unhesitatingly regard this form of frond as specifically indistinguishable from *Nilssonia mediana.*

Upper Shale, Scarborough.

39,298. Pl. IV. Fig. 3.

A frond 20 cm. long, illustrating the very unequal breadth of the segments. Associated with fragments of *Tæniopteris vittata.*

V. 3558. Pl. IV. Fig. 4.

A still narrower frond, in which the apical portion has been preserved. This specimen shows the finer texture of the segments as distinguished from the thicker and coarser segments of *N. compta.* Labelled by Bean *Pterophyllum angustifolium.*

Gristhorpe Bay.

Other specimens: — **39,294, 39,308, 39,309** (also *Tæniopteris vittata*).

3. Nilssonia tenuinervis, Nathorst.

[Berättelse, p. 35, 1880.]

(Text-fig. 41.)

1880. *Nilssonia tenuinervis*, Nathorst, Berättelse, p. 35.
1894. ? *Nilssonia polymorpha*, Bartholin, Bot. Tidsskrift, pl. i. figs. 5, 6.
1900. *Nilssonia tenuinervis*, Seward, Manchester Lit. & Phil. Soc. vol. xliv. p. 4.

Frond linear; the lamina entire, characterized by the numerous fine veins given off almost at right angles from the axis.

Nathorst proposed the specific name *tenuinervis* for a few examples of *Nilssonia* fronds from the Inferior Oolite of the Yorkshire

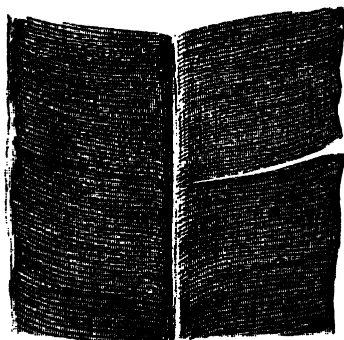


Fig. 41.—*Nilssonia tenuinervis*, Nathorst. No. 13,502. (Nat. size.)

coast, which differ from the other species of the genus in the greater number and fineness of the lateral veins; he notices the resemblance which the species bears to the genus *Tæniopteris*. Nathorst's species may be compared with *Nilssonia orientalis*, Heer.[1]

Nathorst's species appears to be represented by three specimens in the National Collection and by a few others in the Museums of Manchester and other places.

[1] Heer (78²), pl. iv. figs. 4–9; Nathorst (97), pl. i. fig. 18.

13,502. A specimen 13 cm. long and 4·5 cm. broad. The numerous delicate veins are clearly shown, curving slightly downwards towards the midrib; the texture of the leaf appears to be more delicate than in *Tæniopteris*.

Gristhorpe Bay. *Presented by Dr. Murray.*

Other specimens:—**V. 3674, ? 39,216.**

Genus **CTENIS**, Lindley & Hutton.

[**Foss. Flor. vol. ii. pl. ciii. 1834.**]

1. **Ctenis falcata,** Lindley & Hutton.
2. **Ctenis,** sp.

In 1829 Phillips described a plant from the Oolitic rocks of the Yorkshire coast under the name *Cycadites sulcicaulis*,[1] and in 1834 Lindley & Hutton[2] substituted the name *Ctenis falcata*, altering the generic designation on the ground that the venation did not agree with that of *Cycadites*. The authors of the *Fossil Flora* compared this plant with a species of *Acrostichum* and with Palms, but considered that it should be included among the Cycadaceæ. They proposed to apply the generic name *Ctenis* to "all leaves having the general character of Cycadeæ, but with the veins connected by forks or transverse bars."

There has been considerable difference of opinion among palæobotanical writers as to the position of *Ctenis* in the plant kingdom; some authors—Sternberg, Brongniart, Schimper, and others—have regarded it as a Cycad, while by many others it has been included among the Ferns. Without giving the history of the views expressed as to the botanical position of *Ctenis*, we may briefly consider the evidence on which the genus has been referred to the Ferns rather than to the Cycads.

In 1868 Schenk[3] discovered certain characters in a specimen of Ettingshausen's species *Tæniopteris asplenioides*, which led him to substitute the generic designation *Ctenis*. The veins of the broad linear segments of the pinnate frond were found to agree in their

[1] Phillips (29), pl. vii. fig. 21.
[2] Lindley & Hutton (34), pl. ciii.
[3] Schenk (68), p. 220, pl. xxv. figs. 1 and 1*a*.

lateral anastomoses with the genus *Ctenis*, and the lower surface of the segments was found to be covered with small circular projections regarded by Schenk as sporangia. The preservation of the specimen did not permit of any microscopical examination of



FIG. 42.—*Ctenis*, sp. (Nat. size.) From a specimen in the Manchester Museum (No. 53).

[I am indebted to the Literary and Philosophical Society of Manchester for the use of the blocks from which Figs. 42 and 43 have been printed.]

the epidermal cells or 'sporangia.' Additional evidence bearing on the systematic position of *Ctenis* has been furnished in recent

years by Raciborski and Staub. The former author, in his *Fossil Flora of the Cracow District*, describes several species of *Ctenis*,[1] some of which exhibit circular projections on the surface of the segments similar to those noticed by Schenk. The epidermal cells of the segments bear several circular projections which Raciborski regards as sori or sporangia, and accepts as evidence of a Filicinean affinity; he was, however, unable to recognize any actual sporangial structure. In a recent paper by Staub[2] on species of *Ctenis*, an unusually large frond of Liassic age, reaching a length of 2 metres, is described under the name *Ctenis hungarica*; on the segments of this frond were found small depressions which the author of the species speaks of as sori. We see, then, that the inclusion of *Ctenis* among the ferns rests on inconclusive evidence, and no proof has been adduced that the circular elevations or depressions on the epidermal cells are of the nature of sori or sporangia.

In his *Floran vid Bjuf* Nathorst[3] described some long and broad leaves with reticulate venation, which he referred to a new genus, *Anthrophyopsis*, on account of their resemblance to the simple fronds of the polypodiaceous fern *Anthrophyum*. In 1879 Nathorst transferred these Rhætic specimens to the genus *Ctenis*, the supposed leaves being recognized as detached and fragmentary segments of a pinnate frond. Some of the figures of the Scanian fossils show circular elevations on the epidermis like those already referred to. My own observations lead me to regard the evidence hitherto relied on in favour of placing *Ctenis* among the ferns as insufficient, and I believe the general habit of the leaves is a strong argument for including the species of this genus among the Cycadales. A specimen in the Manchester Museum from the Yorkshire coast rocks was described by Nathorst[4] in 1880 as probably a new species of *Anthrophyopsis*; a recent examination of this specimen has afforded important information as to the nature of the supposed sori described by Raciborski, Schenk, Nathorst, and Staub. The specimen (Text-fig. 42) consists of a portion of a pinna 9 cm. in length and 2·6 cm. broad, traversed by short parallel veins which are connected here and there by oblique transverse veins; the epidermal

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[1] Raciborski (94), p. 51, pls. xvi.–xviii.
[2] Staub (96).
[3] Nathorst (78[1]).
[4] Nathorst (80[1]), p. 83.

cells, which are well preserved, and readily examined under the microscope after suitable treatment, are characterized by prominent circular papillæ agreeing precisely with those figured as sori by Raciborski and other authors. It is not uncommon among recent plants to find the surface cells of a leaf provided with conical elevations or papillæ; the circular elevations on the epidermal cells of *Ctenis* (Text-fig. 43, A P and B) are identical with those met with in recent plants. The enlarged drawing (Text-fig. 43) demonstrates the nature of these sorus-like projections as seen in the *Ctenis* segments in the Manchester Museum. The three epidermal

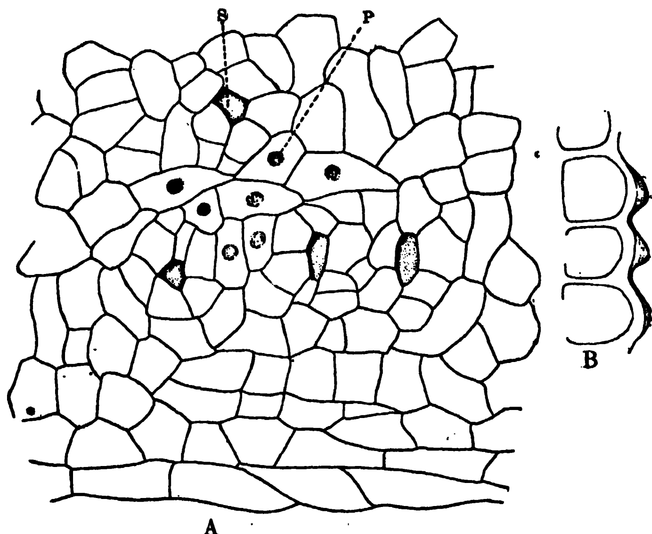


FIG. 43.—*Ctenis*, sp. Epidermal cells of the specimen shown in Fig. 42, highly magnified.
A. Cells in surface-view; B. side-view of the epidermal cells, showing the papillæ.
P = papillæ; S = stomata.

cells shown in side-view in Text-fig. 43 B illustrates the nature of the circular dots seen in surface-view in Fig. 43, P; the shaded areas in the drawing mark the position of depressions, which no doubt occur immediately above stomata (Fig. 43, S).

In view of these facts, I prefer to retain *Ctenis* as a Cycadean genus characterized by pinnate fronds with linear segments traversed by parallel veins connected at intervals by lateral anastomoses.

1. Ctenis falcata, Lindley & Hutton.

[Foss. Flor. vol. ii. pl. ciii. 1834.]

(Pl. VIII. Fig. 2.)

1828. *Zamia longifolia*, Brongniart, Prodrome, p. 94.
1829. *Cycadites sulcicaulis*, Phillips, Geol. Yorks. p. 148, pl. vii. fig. 21.
1834. *Ctenis falcata*, Lindley & Hutton, Foss. Flor. pl. ciii.
1838. *Ctenis falcata*, Sternberg, Flor. Vorwelt, vii. p. 163.
1841. *Zamites longifolia*, Morris, Annals, vol. vii. p. 116.
1845. *Ctenis falcata*, Unger, Syn. plant. foss. p. 165.
1848. *Ctenis falcata*, Bronn, Ind. Pal. p. 355.
1849. *Ctenis falcata*, Brongniart, Tableau, p. 106.
1850. *Ctenis falcata*, Unger, Gen. spec. foss. p. 307.
1854. *Ctenis falcata*, Morris, Brit. Foss. p. 6.
1856. *Ctenis falcata*, Zigno, Flor. foss. Oolit. vol. i. p. 190, pl. xxiv. figs. 1–3.
1864. *Ctenis falcata*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1870. *Pterophyllum falcatum*, Schimper, Trait. pal. vég. vol. ii. p. 137.
1874. *Ctenis falcata*, Schimper, ibid. vol. iii. p. 521.
1875. *Ctenis falcata*, Phillips, Geol. Yorks. p. 218, pl. vii. fig. 21.
1876. Cf. *Ctenis orientalis*, Heer, Flor. foss. Arct. vol. iv. (2), p. 105, pl. xxii. fig. 2.
1892. *Ctenis falcata*, Fox-Strangways, Tab. Foss. p. 137.
1896. *Ctenis falcata*, Staub, Földt. Közl. vol. xxvi. p. 1.

Frond pinnate; the linear pinnæ are attached obliquely or almost at right angles to the sides of the rachis, and as regards their attachment they resemble those of the genus *Pterophyllum*; the long pinnæ or segments, which reach a length of more than 10 cm., taper gradually towards an acuminate apex, which is seldom preserved; they are traversed by several parallel veins, connected by frequent lateral anastomoses, which diverge slightly in the broader basal region of the pinnæ (Pl. VIII. Fig. 2). At the base of each pinna the lamina becomes broader, the upper margin is bent slightly upwards on the rachis, and the lower margin is strongly decurrent. The frond terminates in two pinnæ placed almost parallel to the long axis of the leaf.

The name *Zamia longifolia*, used by Brongniart in his *Prodrome* in 1828,[1] has been superseded by *Ctenis falcata* of Lindley & Hutton. A good specimen of *Ctenis* from Cayton, near Scarborough, in the

[1] Brongniart (28[1]), p. 94.

Natural History Museum, Paris, bears Brongniart's name *Zamia longifolia*, and demonstrates that this designation was applied to the pinnate frond now known as *Ctenis falcata*.

33,763. Pl. VIII. Fig. 2.

A good specimen, showing very clearly the manner of attachment and venation of the pinnæ. The longest pinna is rather more than 12 cm. long, without the apex, and 1·2 cm. wide. Each pinna is broadest at the base, and the lower margin is decurrent on the rachis, being overlapped by the upper edge of the pinna next below.

Gristhorpe Bay. *Mantell Coll.*

V. 3559. Similar to the specimen shown in pl. ciii. of Lindley and Hutton. Fragments of apical portions of fronds; the pinnæ are more oblique to the rachis than in **38,763**, and their lower margins strongly decurrent. The veins are clearly shown.

Bowerbank Coll.

V. 3560. Parts of fronds with long and gradually tapering pinnæ; the longest pinna is about 13 cm. long, and near the apex only 4 mm. in breadth. This example affords an indication of the long and tapered pinnæ which characterized the species; in most specimens the distal part of the pinnæ is not shown.

39,206. Similar to **38,763** (Pl. VIII. Fig. 2), but with rather narrower pinnæ. The irregularly striated surface of the rachis is distinctly shown, with the pinnæ attached to the margin.

Upper Shale, Scarborough.

Other specimens:—**8089, 13,514, 38,762, 39,205.**

2. Ctenis, sp.

(Text-figs. 42 and 43.)

1880. *Anthrophyopsis*, nov. sp., Nathorst, Reseberätt. p. 83.
1892. *Anthrophyopsis*, nov. sp., Fox-Strangways, Tab. Foss. p. 129.
1900. *Ctenis*, sp., Seward, Manchester Lit. & Phil. Soc. vol. xliv. p. 21, pl. ii. fig. 4.

The specimen in the Manchester Collection referred to as *Ctenis*, sp., is too small to enable one to give a diagnosis of the

characters of the frond of which it formed a part. The form of the segment with the stout veins and lateral connections is shown in Text-fig. 42. The epidermal papillæ (Text-fig. 43) have already been described in the remarks on the genus *Ctenis*. So far as it is possible to base any comparison on the single specimen of this type of *Ctenis*, which is not represented in the British Museum, the frond probably agreed fairly closely with that of *Ctenis fallax*, Nath., from the Rhætic of Scania; it differs from *Ctenis falcata* in the greater breadth and coarser venation of the pinnæ.

Genus **PTILOZAMITES**, Nathorst.

[Flor. Höganäs och Helsingborg, p. 21, 1878.]

The genus *Ptilozamites* was instituted by Nathorst in 1878, and defined as follows:—"Folia petiolata linearia, regulariter pinnata, pinnis tota latitudine basis insertis, margine anteriore recta vel paulum concava, posteriore rotundata, nervis dichotomis radiantibus præsertim versus marginem posteriorem. Differt a *Ptilophyllo* margine anteriore pinnarum non subauriculata ab *Anomozamite* a quo nonnullæ species vix distinguendæ nervis radiantibus non parallelis."[1]

At a later date this author proposed the generic name *Ctenozamites* for fronds of the *Ptilozamites* type which are bipinnate and not simply pinnate in their habit; this genus has been employed by Schenk in his description of a bipinnate frond—*Ctenozamites cycadea*—from Persia.[2]

We may make use of the more recent designation as a subgenus of *Ptilozamites*, and apply it to bipinnate fronds such as *Ctenis Leckenbyi*, Bean MS. The data we at present possess is insufficient to enable us to decide with certainty the botanical affinity of *Ptilozamites*, but the probability is that the fronds, having the characters of Nathorst's genus, may be best compared with the recent Cycad, *Bowenia spectabilis*, Hook.

[1] Nathorst (78[3]), p. 21.
[2] Schenk (87), p. 5, pls. iii., iv., vi.-ix.

Ptilozamites (Ctenozamites) Leckenbyi (Leckenby, ex Bean MS.).

[Quart. Journ. Geol. Soc. vol. xx. p. 78, pl. x. fig. 1, 1864.]

1856. *Odontopteris Leckenbyi*, Zigno, Flor. foss. Oolit. vol. i. p. 111.
1864. *Ctenis Leckenbyi*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 78, pl. x. fig. 1.
1869. *Cycadopteris Leckenbyi*, Schimper, Trait. pal. vég. vol. i. p. 487.
1875. *Odontopteris Leckenbyi*, Phillips, Geol. Yorks. p. 218, lign. 41.
1880. *Ptilozamites (Ctenopteris) Leckenbyi*, Nathorst, Berätt. p. 83.
1892. *Ptilozamites Leckenbyi*, Fox-Strangways, Tab. Foss. p. 141.

Type-specimen. Woodwardian Museum, Cambridge (Leckenby Coll., No. 245).

Frond bipinnate; rachis stout, giving off pinnæ at an acute angle; the pinnæ have slender axes bearing falcate segments attached by the whole of the broad base, the apices are obtusely pointed and directed upwards, in the distal portion the margin may be finely denticulate; several veins enter the base of each segment and diverge slightly, and they branch dichotomously once or more as they pass to the distal edge of the segment, which is formed of the strongly bent posterior margin.

This species does not appear to be represented by any specimens in the British Museum Collection of Yorkshire plants; the only examples I have met with are those in the Leckenby Collection, Cambridge, the best of which was figured in 1864 under Bean's manuscript name, *Ctenis Leckenbyi*.

I am indebted to Professor Nathorst for calling my attention to a specimen in the Stockholm Museum in which the margin of the segments is finely denticulate towards the apex.

The species which present the closest agreement with *Ptilozamites (Ctenozamites) Leckenbyi* are those described by Nathorst from Scania,[1] and the still finer examples figured by Schenk[2] from Persia. A specimen in the British Museum (No. 40,674) from the Liassic beds of the south-west of England bears a strong resemblance to Leckenby's Inferior Oolite species.

Fontaine has described several examples of fronds not unlike *Ptilozamites Leckenbyi* from the Potomac beds; the species

[1] Nathorst (78[1]), pls. vii., xi., and xii.; (78[3]), pl. iii.
[2] Schenk (87), pls. iii., iv., vi.–ix.

Ctenopteris insignis, Font.,[1] may be specially compared with the English type. It is worthy of note that some of the frond fragments described by Feistmantel from the Upper Mesozoic beds of Queensland as *Thinnfeldia odontopteroides* (Morr.) should be referred to *Ctenozamites*.[2]

Genus DIOONITES, Miquel.

[Tijdsch. Wis. Nat. Wet. vol. iv. p. 205, 1851.]

The solitary specimen which I have referred to this genus does not afford entirely satisfactory evidence as to the precise manner of attachment of the pinnæ to the rachis, but it is probably better to adopt the designation *Dioonites* than any other generic name. I have elsewhere given a comprehensive diagnosis of this genus.[3]

Dioonites Nathorsti, sp. nov.

Type-specimen. Woodwardian Museum, Cambridge (Leckenby Coll., No. 222).

Frond pinnate; the pinnæ are given off from a fairly stout rachis at an acute angle. The pinnæ are narrow and linear, 3–4 mm. wide, and reaching a length of 8 cm.; they are attached by the whole of the base, which is slightly wider than the rest of the pinnæ; the pinnæ are tapered gradually to an acuminate apex, and are traversed by about eight parallel veins.

On the back of the type-specimen Nathorst has written: "This is a new species, belonging to some genus allied to *Pterophyllum*." In the best specimen, which is probably seen from the upper side, the rachis has a length of 14·5 cm.; the pinnæ appear to be attached laterally, but this is, I believe, due to the exposure of the dorsal surface of the frond. The frond must have reached a considerable length, and the breadth, which is fairly uniform in the portion preserved, measures approximately 15–16 cm.

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[1] Fontaine (89), p. 156, pls. lxi.–lxiii.

[2] Feistmantel (90), p. 101, pl. xxix. figs. 1 and 5.

[3] Seward (95), p. 41.

In all probability the Leckenby specimen represents a new species; I have chosen the specific name *Nathorsti* after my friend Professor Nathorst, of Stockholm, whose work has materially aided me in the identification of the Yorkshire plants.

Dr. Richards, who printed a list of British Cycadean leaves in 1884,[1] refers this specimen to an Indian species, *Pterophyllum distans*, Oldham & Morris, and adopts the generic name *Dioonites*. The frond so named by Morris from the Rajmahal Hills is represented by imperfect fragments, which bear a close resemblance to the Yorkshire specimen, but the evidence is not, I believe, sufficient to justify us in making use of his specific designation.

Among other Cycadean fronds from Indian localities which are very similar to *Dioonites Nathorsti*, may be mentioned *Zamites proximus*, Feistmantel,[2] *Cycadites Blanfordianus*, Oldham & Morris,[3] *Pterophyllum Footeanum*, Feistmantel.[4] Another species similar to *Dioonites Nathorsti* is that described by Jaeger as *Osmundites pectinatus*[5] (= *Pterophyllum Jaegeri*, Brongn.). The Rhætic species, *Pterophyllum Braunianum*, Göpp.,[6] and *P. carnallianum*, Göpp.,[7] may also be compared with the English type.

The frond figured by Hosius & Von Marck[8] as *Dioonites abietinus*, Miq., bears a resemblance to *D. Nathorsti*.

A Genus of Doubtful Affinity.

Genus PODOZAMITES, Braun.

[Münster: Beiträge Petrefact. Heft vi. p. 36, 1843.]

Braun proposed this generic name, as a substitute for *Zamia* of Brongniart and *Zamites* of Presl, for such species as *Zamites*

1 Richards (84), p. 3.
2 Feistmantel (77[1]), p. 62, pl. xli. figs. 1 and 2.
3 Oldham & Morris (63), pl. ix. fig. 2.
4 Feistmantel (79), pl. vi.
5 Jaeger (27), pl. v. fig. 6.
6 Schenk (67), p. 164, pl. xxxviii. figs. 1–10.
7 Ibid. p. 163, pl. xxxix. fig. 4.
8 Hosius & Von Marck (79), pl. xliv.

distans, Presl, and *Z. lanceolatus*, L. & H. The following is his definition of the genus:—

"Leaves pinnate; segments distant, alternate, contracted towards the base. Veins divergent at the base of the segments, approximately parallel in the median and apical portions."

The definition of *Podozamites*, which has been somewhat modified by later writers, may be stated as follows:—

Frond (or shoot?) pinnate, the slender axis bears segments, usually somewhat far apart and at unequal distances, which vary considerably in both size and shape, from narrow linear and acuminate to broadly oval and obtusely pointed segments; the segments are constricted basally, and traversed by numerous veins divergent at the base and approximately parallel to the edges of the narrower segments, but convergent in the distal portions of the broader segments. The base of the petiole may be enclosed by broad acuminate imbricating scale-leaves.

It has been the custom to include this widely-spread genus in the Cycadaceæ, but it is worthy of note that the resemblance which the fronds possess to a shoot of *Agathis australis*, Salisb., a New Zealand Conifer, renders it by no means impossible that its true position is among the Coniferæ. Such specimens as we possess do not enable us to determine the precise manner of attachment of the segments, but there are indications of a spiral phyllotaxis which would afford a strong argument in favour of the relationship of *Podozamites* to the Coniferæ. Among recent Cycads, there are species of *Zamia*, *Ceratozamia*, *Macrozamia*, and *Encephalartos*, which closely resemble *Podozamites lanceolatus*, but in the Cycadean fronds the segments are more regularly disposed than in most of the examples of the fossil species. Schenk prefers the generic name *Zamites* to *Podozamites*; this author has figured a specimen which bears scale-leaves at the base of the petiole,[1] suggesting an origin from a lateral bud such as is occasionally produced by recent plants of the genus *Cycas*;[2] the scales, as Schenk points out, may be compared also with the bud-scales of *Agathis*.

Another example of *Podozamites* (*P. lanceolatus minor*[3]) is figured

[1] Schenk (67), pl. xxxvi. fig. 3.

[2] Loc. cit. p. 160.

[3] Nathorst (78[1]), pl. xvi. figs. 10 and 10*a*.

by Nathorst from the Rhætic beds of Bjuf, in which the lower part of the petiole is clasped by a few imbricate bracts bearing a striking resemblance to bud-scales.

The structure of the epidermis of the pinnæ is described by Schenk, and regarded by him as an argument against an alliance with the genus *Agathis*; the form of the epidermal cells, however, does not, I believe, constitute an important objection to the suggestion that *Podozamites* may represent the shoot of a Conifer rather than the pinnate frond of a Cycad.

In addition to the type represented by *Podozamites lanceolatus*, there are others characterized by broadly oval segments,[1] which suggest a comparison with the broad leaves of *Agathis Dammara*, Rich.

It is unsatisfactory to express a definite opinion in favour of assigning *Podozamites* to the Coniferæ rather than to the Cycadaceæ on such evidence as is before us, but I am disposed to favour the view that the plants, which it has been customary to refer to Braun's genus, may be more correctly compared with the Conifer *Agathis* than with any recent Cycad.

Podozamites lanceolatus (Lindley & Hutton).

[Foss. Flor. vol. iii. pl. cxciv. 1836.]

(Text-fig. 44.)

1836. *Zamia lanceolatus*, Lindley & Hutton, Foss. Flor. pl. cxciv.
1848. *Zamites lanceolatus*, Bronn, Ind. Pal. p. 1378.
1849. *Zamites lanceolatus*, Brongniart, Tableau, p. 106.
1850. *Zamites lanceolatus*, Unger, Gen. spec. plant. foss. p. 282.
1853. ? *Zamites Staueri*, Ettingshausen, Lias Oolit. Pflanz. pl. ii. fig. 5.
1854. *Zamites lanceolatus*, Morris, Brit. Foss. p. 25.
1864. *Zamites lanceolatus*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
1866. ? *Podozamites lanceolatus*, Newberry, Foss. Plants China, pl. ix. fig. 7.
1868. *Zamites lanceolatus*, Eichwald, Leth. Ross. pl. iii. fig. 1.
1870. *Podozamites lanceolatus*, Schimper, Trait. pal. vég. vol. ii. p. 160.
1875. *Zamites lanceolatus*, Phillips, Geol. Yorks. p. 225, lign. 54.
? *Podozamites lanceolatus*, Feistmantel, Pal. Ind. pl. iii. figs. 7–17; pl. iv. figs. 1–10.

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[1] E.g. *Podozamites Reinii*, Geyler (77), pl. xxxiii., xxxiv.; Yokoyama (89), pl. vi.

1877. *Podozamites lanceolatus*, Heer, Flor. foss. Arct. vol. iv. (3), pl. vii. figs. 1–7.
P. lanceolatus, ibid. vol. iv. (2), pl. xxiii. fig. 4; pl. xxvi. figs. 2 and 3; pl. xxvii. figs. 1 and 5.
P. lanceolatus minor, ibid. pl. xxvii. figs. 6–8.
Cf. *P. ensiformis*, ibid. pl. iv. figs. 8–10; pl. xx. fig. 6*b*.
? *P. lanceolatus*, Geyler, Palæont. vol. xxiv. pl. xxxiii. figs. 1–4; pl. xxxiv. figs. 3–5.
? *P. ensiformis*, ibid. pl. xxxii. fig. 1.
1881. *Podozamites lanceolatus*, Zigno, Flor. foss. Oolit. vol. ii. p. 119.
1885. *Podozamites lanceolatus*, Dawson, Trans. R. Soc. Canada, pl. i. fig. 3.
1887. ? *Podozamites lanceolatus*, Schenk, Foss. Pflanz. Albourskette, pl. viii. fig. 42.
1889. *Podozamites lanceolatus*, Yokoyama, Journ. Coll. Sci. Japan, vol. iii. pp. 45 et seq., pls. iv. etc.
P. lanceolatus, Heer, loc. cit. vol. v. (2), pl. v. figs. 1–11.
P. angustifolius, ibid. pl. v. figs. 11 and 12.
1890. *Podozamites lanceolatus*, Schenk, in Zittel, p. 218.
1892. *Podozamites lanceolatus*, Fox-Strangways, Tab. Foss. p. 140.
1894. ? *Podozamites lanceolatus*, Yokoyama, loc. cit. vol. vii. p. 222, pl. xxiii. figs. 4 and 5.
1896. *Podozamites lanceolatus*, Hartz, Med. Grön. vol. xix. p. 237, pl. xiii. figs. 1, 3, 4, 5, 6, 8, and 9; pl. xiv. figs. 1–3 and 5.
P. Schenkii, ibid. pl. xiii. figs. 2 and 7.
1897. *Podozamites lanceolatus*, Nathorst, Flor. Spitzb. p. 13, pl. i. fig. 5.
P. angustifolius, Bartholin, Dan. Geol. Anders. pl. A, figs. 9 and 10.
1900. *Podozamites lanceolatus*, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 15.

Type-specimen of Lindley & Hutton in the Manchester Museum, Owens College (No. 321).

Frond pinnate; rachis slender, giving off at unequal intervals linear lanceolate segments; the segments are characterized by their gradually tapered acuminate apices and constricted bases; they are traversed by several parallel veins.

The type-specimen was obtained by Williamson from Haiburn Wyke, and presented with a drawing and brief description to Lindley; it is described by the former as "no doubt produced by some one of the Cycadeoideous stems of the Oolitic rocks." The rachis is 13 cm. in length, bearing irregularly disposed linear pinnæ, about 7 mm. broad, attached by a narrow base. The longest pinna measures 7 cm. in length, and tapers gradually to an acuminate apex, but becomes suddenly narrow towards the basal end; a few of the pinnæ appear to be laterally attached to the rachis, with a slightly decurrent lower margin, but in one or two of

the pinnæ the attachment appears to be rather on the upper face of the rachis. The veins are numerous and parallel, as in the Cycadean genus *Zamites*. The specimen is not sufficiently well preserved to enable us to determine the exact manner of attachment of the pinnæ, and it is very doubtful if all of them are shown in their original position. It is probable that the pinnæ of this species were deciduous and separated from the rachis by a definite separation-surface, and this circumstance adds to the danger of assuming that all the leaflets are in their original positions.[1]

The considerable amount of variation in the size and form of the segments has given rise to the institution, by Heer and other authors, of several varietal terms, but it is improbable that the numerous so-called varieties were borne by distinct plants. It would seem that the species is characterized by a marked tendency to variation in the form and dimensions of the linear-lanceolate segments. A specimen in the York Museum, which cannot reasonably be separated specifically from the ordinary type such as is represented in Text-fig. 44, illustrates this variability. The pinnæ in the York specimen are approximately 4 mm. in breadth; they are arranged on the shale at unequal distances apart, and attached by a narrow base to the slender rachis.

Among the numerous specimens figured by Heer from Jurassic rocks of Siberia and Spitzbergen, there are several which appear to be identical with *Podozamites lanceolatus* (L. & H.), and others with broader segments (e.g. *P. pulchellus*[2]) which represent another specific type.

We find several Rhætic examples of *Podozamites*[3] referred to such species as *P. lanceolatus*, *P. distans*, *P. Emmonsi*, and others, which appear to be almost, if not quite, identical with the type-species of Lindley & Hutton; it is clear that this plant was one of the most widely spread elements in both the Rhætic and Oolite floras.

39,303. Text-fig. 44.

This specimen has a length of 17·5 cm. from the base to the tip of the highest leaflet. The preservation is unfortunately not very

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[1] Seward (00), p. 16.
[2] Heer (77), vol. iv. (1), pl. ix. figs. 10–14.
[3] Vide Nathorst (78); Schenk (67); Fontaine (83), pl. xxxiii. fig. 2, etc.



FIG. 44.—*Podozamites lanceolatus* (L. & H.). (39,303.)

good as regards the manner of attachment and venation of the leaflets. As shown in the drawing, the pinnæ (or leaflets) are not regularly disposed on the axis, but occur at irregular distances, thus differing from the more regular arrangement of pinnæ in a Cycadean frond. Each 'pinna' is narrower at the base and tapers gradually to an acuminate tip; the veins are numerous and approximately parallel to the edges of the leaflets. The figured specimen bears a close resemblance to the type-specimen of Lindley & Hutton (in the Manchester Museum); cf. also the figure given by Schenk in the *Flora der Grenzschichten* of *Zamites distans*, Presl, var. *longifolia*.[1] A specimen from Bayreuth (Keuper) in the Museum Collection (No. 1184) also bears a close resemblance to 39,303.

Near Scarborough. *Bean Coll.*

[1] Schenk (67), pl. xxxvii. fig. 1.

Class GINKGOALES.

Family GINKGOACEÆ.

The genus *Ginkgo* (or *Salisburia*), the Maidenhair-tree of China and Japan, has long been recognized as an isolated member of the Coniferæ; but in recent years it has been shown that there are good grounds for giving expression to its peculiarities by instituting a special division of Gymnosperms for the inclusion of this monotypic genus.

In a recent number of *Die Natürlichen Pflanzenfamilien* by Engler & Prantl, the name Ginkoales is adopted as a class-designation, and in this subdivision of the Gymnosperms is included the family Ginkgoaceæ, represented by the single living genus *Ginkgo*. The following definition of the Ginkgoaceæ is quoted from Engler & Prantl:—[1]

"Flowers unisexual, diœcious, without perianth. Male flowers shortly stalked, long, and of loose or open structure. Stamens with two free pollen-sacs. Pollen spherical, producing two spermatozoids before fertilization. Female flowers supported on a long axis bearing usually two terminal carpels, and rarely more than two; these are stalked spherical bodies, the seed being surrounded at the base by an enveloping collar-like structure. Ovules with one integument. The ripe seeds have a fleshy outer coat and a hard, strong, inner coat. Embryo with two cotyledons. Leaves stalked; the lamina divided into two or more lobes."

The most important advance made in recent years as regards our knowledge of the morphology and natural position of *Ginkgo* is the discovery by the Japanese botanist Hirase[2] of large ciliated and spirally coiled spermatozoids, which are produced in the pollen-tube shortly before fertilization. Among Conifers the male generative

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[1] Engler & Prantl (97), p. 19.

[2] Hirase (97) (98).

cells, so far as we know at present, are always non-motile; but, on the other hand, spermatozoids similar to those of *Ginkgo* have recently been discovered in two genera of Cycads, *Cycas*[1] and *Zamia*.[2] The fertilization of the egg-cell by means of spermatozoids affords an important distinction between the Ginkgoales and Coniferæ, and serves as another connecting link between *Ginkgo* and the Cycads. There are several features, as regards both vegetative and reproductive characters, in which *Ginkgo* shows a distinct approach to the recent Cycads; and the Cycadaceæ are linked to the Ferns by several Palæozoic genera of plants, which it is now customary to include in the class Cycadofilices. In the Ginkgoaceæ, then, we have a family connected by several characters with the Cycadaceæ, and, like the Cycads, exhibiting certain points of contact with the Ferns.

Ginkgo is the sole surviving representative of the Ginkgoales, but there is good reason for including in the same class certain fossil genera characteristic of the Mesozoic epoch. In the first place we have several fossil species usually referred to *Ginkgo* itself; the genus *Baiera* is another closely allied type which should be placed in the same family, and I believe we may reasonably include in the Ginkgoaceæ the type of female flower to which Carruthers gave the name *Beania*.[3] There are several other genera which are often referred to the same family with *Ginkgo*, both of Palæozoic and Mesozoic age, but these need not be discussed here. The only other genus, represented in the Inferior Oolite strata of East Yorkshire, which need be considered as a possible claimant for membership of the Ginkgoaceæ is Heer's *Czekanowskia*, in which is now included the plant named by Lindley & Hutton *Solenites Murrayana*; for reasons stated elsewhere I have considered *Czekanowskia* as a Conifer of which the precise position is a matter of uncertainty. The evidence on which a close relationship of Heer's genus with *Ginkgo* has frequently been assumed to exist, is not strong enough to justify any statement which would imply more than a possibility of the two genera belonging to the same family.

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1 Ikeno (98).
2 Webber (97).
3 Carruthers (67).

Genus GINKGO, Kæmpfer.

[Amœnitatem exoticarum, p. 811, 1712. Linnæus, Mantissa Plantarum, p. 313, 1771.]

1. Ginkgo digitata (Brongniart).

2. Ginkgo whitbiensis, Nathorst.

The maidenhair-tree was first described under the name *Ginkgo* by Kæmpfer in 1712;[1] this author published a drawing of a shoot and ovule, and spoke of the plant as *Ginkgo* or Gínan, *vulgo* Itsjo: "arbor nucifera folio adiantino." Linnæus adopted Kæmpfer's designation, and referred to the plant as *Ginkgo biloba*. In 1797 Smith[2] placed this species among the Conifers; he proposed the generic name *Salisburia* and a new specific designation *adiantifolia* in place of the "uncouth name *Gingko* and the incorrect specific term *biloba*." Since 1797 the names *Ginkgo biloba* and *Salisburia adiantifolia* have both remained in common use. Among the numerous references to *Gingko* in the literature of the present century we find several records of the development of both male and female flowers in trees grown at Montpelier, Vienna, Kew, and elsewhere. By Richard, Endlicher, and several other authors, *Ginkgo* has been placed in the family Taxineæ; but Eichler, in an important contribution to Martius' *Flora Brasiliensis*, proposed to include the genus in a separate tribe, the Salisburyeæ.[3] In 1840 Zuccarini[4] called attention to the resemblance of the young leaves of *Ginkgo* to those of the African Cycad *Encephalartos horridus*, and instituted a comparison between the short shoots of the maidenhair-tree and the main stem of Cycads. During the past few decades new facts have gradually been brought to light demonstrating other and more important resemblances between *Ginkgo* and the Cycads, and finally the discovery of motile spermatozoids in both Cycads and *Ginkgo*

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[1] Kæmpfer (1712), p. 811. A more complete historical sketch of *Ginkgo* is given in a recent paper by Miss Gowan and myself: vide Seward & Gowan (00[2]), p. 111.

[2] Smith (1797).

[3] Eichler (52).

[4] Zuccarini (40).

afforded sufficient reason for the institution of a separate subdivision of the Gymnosperms in which to include Kæmpfer's genus.

Ginkgo is sometimes spoken of as unknown in a wild condition, but this statement has recently been challenged by Mrs. Bishop (Miss Bird), who speaks of having "met with several fine specimens in the magnificent forests which surround the sources of the Gold River and the smaller Min in Western China."[1]

The genus *Ginkgo*, as represented by the single living species *Ginkgo biloba*, may be diagnosed as follows:—

A tree of pyramidal form reaching a height of over 30 metres, with smooth grey bark, characterized among existing Gymnosperms by its flat, broad leaves, with the *Cyclopteris* type of venation, deciduous in the autumn, possessing a long and slender petiole slightly grooved on its upper surface and a lamina varying considerably in size and shape, occasionally fan-shaped and entire, but more frequently divided into two halves by a more or less deep median division, or subdivided into several wedge-shaped lobes. The foliage-leaves occur either scattered on long shoots or crowded at the apex of short shoots; the latter form of leaf-bearing axis often passes by apical growth into the long shoots bearing scattered leaves separated by long internodes.

Flowers diœcious. The male flowers, which occur in the axils of scale-leaves, have the form of a stalked central axis bearing scattered, loosely disposed stamens; each stamen consists of a slender filament terminating in a very small apical scale, bearing usually two, sometimes three or four, elliptical pollen-sacs which open by longitudinal dehiscence. The pollen-grains develop a rudimentary prothallus consisting of a few cells, and before fertilization two large spirally coiled multiciliate spermatozoids are produced from the generative nuclei in the pollen-tube. The female flowers usually have the form of a long peduncle bearing two terminal elliptical ovules enclosed at the base by a collar-like envelope representing a reduced carpellary leaf. Abnormal female flowers, possessing more than two ovules, are not infrequently met with. Each ovule consists of a nucellus enclosed by a single

[1] Letter to the London *Standard*, Aug. 17, 1899. Vide also Bird (80), vol. ii. p. 144.

integument, which in the ripe seed forms a thick fleshy covering surrounding a hard woody shell; the nucellus possesses a well-marked pollen-chamber, and in the mature ovule the greater part of the nucellar tissue is reduced to a thin papery layer enclosing a large embryo-sac which usually contains two archegonia. After fertilization, which may occur either before or after the ovule has fallen from the tree, the egg-cell develops directly into an embryo with two cotyledons.

The secondary wood of *Ginkgo* is composed of tracheids with numerous bordered pits on the radial and not uncommonly on the tangential walls. Resin ducts occur in abundance, both in the pith and in the cortical tissues.

It is unnecessary to enter here into a detailed examination of the histological characteristics of *Ginkgo*; but we may briefly summarize some of the features in which the genus agrees with the Cycadaceæ.

1. The archegonia possess two neck-cells.
2. The seeds are situated at the margin of the carpellary leaves, and have a fleshy testa.
3. The male reproductive cells have the form of motile spermatozoids.
4. The short shoots bear scale-leaves and foliage-leaves, and present a close resemblance to the stems of Cycads.
5. The presence of a large pollen-chamber at the apex of the nucellus.
6. The existence of centripetal wood in the cotyledon-stalk, as also in the foliage-leaf, petiole, and elsewhere.
7. Resemblances in the anatomy of the short shoots to features characteristic of Cycadean structure.

We need not concern ourselves for the present with the various views that have been held as to the morphology of the female flowers, a subject which has given rise to no little controversy, nor need we attempt an exhaustive description of the various features of morphological and phylogenetic importance exhibited by both vegetative and reproductive organs.[1]

The leaves of *Ginkgo biloba*, which Kæmpfer and others have compared with those of the maidenhair fern, are of special

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[1] Vide Seward & Gowan (00).

importance from the point of view of the geological history of the genus. The broad, wedge-shaped or fan-shaped lamina, with its numerous spreading and dichotomously branched veins, at once suggests a comparison with such recent ferns as *Adiantum reniforme*, L., *Trichomanes reniforme*, Forst., *Scolopendrium nigripes*, Hook., *Lindsaya reniformis*, Dry., and others. For many years the fossil leaves of *Ginkgo* were regarded by Brongniart and other authors as species of ferns, and usually included in the genus *Cyclopteris*.

It was Heer who first drew attention to the probable generic identity of certain Mesozoic leaves from the Arctic regions and Northern European localities with the fern-like leaves of the maidenhair-tree.[1] The recognition of these fossil leaves as species of *Ginkgo* rather than as ferns was based on the form of the petiole, which, Heer pointed out, agrees exactly with that of *Ginkgo biloba*, but more especially on the discovery of male flowers practically identical with those of the recent species, and of seeds and short foliage shoots very similar to those of the maidenhair-tree. There are but few recent plants possessing leaves which might be mistaken for those of *Ginkgo*; a few ferns, such as those already mentioned, have leaves in form and venation very similar to the maidenhair-tree; but the form of the petiole and the frequent association of the reproductive structures with fossil leaves, afford confirmatory evidence which enables us to speak with certainty as to many of the fossil forms. Among the Angiosperms *Ginkgo*-like leaves are very rare, and in such a plant as *Hakea Baxteri*, R. Br., the reticulate venation precludes confusion with the fern-like leaf of *Ginkgo*.

From evidence afforded by fossil leaves and flowers it has been possible to draw up a history of the Ginkgoaceæ, which demonstrates the extreme antiquity and wide geographical distribution of *Ginkgo* and other genera. It is true that some of the leaves referred to *Ginkgo* may be ferns, and on the other hand certain so-called fern species might equally well be referred to the Ginkgoaceæ.

In 1881 Heer[1] published an interesting paper on the history of *Ginkgo*-like trees, in which he summarized the available data,

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[1] Heer (81[2]).

concluding that ancestral forms of the recent plant existed as far back as the Upper Carboniferous period. Since this paper was written many new facts have come to light, which enable us to extend the geographical distribution of the family and strengthen Heer's conclusion as to the importance of these Gymnospermous plants in the Mesozoic or even in the Palæozoic epoch.

Such genera as *Ginkgophyllum*, *Saportæa*, *Trichopitys*, *Dicranophyllum*, *Rhipidopsis*, *Whittleseya*, and even *Ginkgo* itself, have been described from Carboniferous and Permian rocks as probable members of the family to which *Ginkgo biloba* belongs. As regards some of these genera, there is hardly sufficient evidence in favour of their inclusion in the Ginkgoales; on the other hand, the close resemblance of the Permian leaves referred to *Ginkgophyllum*, *Ginkgo*, *Saportæa*, and *Baiera*, to the recent plant, render it probable that closely allied species existed in the Palæozoic era. Certain fossil seeds from St. Etienne, of Permian age, described by Brongniart [1] as species of *Cardiocarpus*, are almost identical in structure with *Ginkgo* seeds. It is, however, from Mesozoic strata that we obtain the most striking proof of the abundance of *Ginkgo*-like trees in the vegetation of the past.

Although as a rule it is, for various reasons, preferable to avoid the application of the name of a recent genus to fossil species, yet the generic names *Ginkgo* and *Salisburia* have been so generally used for fossil leaves, and on evidence of a trustworthy nature, that it would be inadvisable to suggest a departure from so well established a custom. The leaves described by Gardner from the Tertiary beds between the basaltic lava-flows of Mull, and referred to Unger's species *Ginkgo adiantoides*, [2] agree so closely with those of the recent species that we may well hesitate to admit even a specific difference. When we come to examine the Jurassic and Cretaceous species, examples are not lacking which also exhibit the closest agreement with the surviving type. It has been pointed out by more than one author that the number of specific names applied to Jurassic *Ginkgo* leaves is excessive; palæobotanical writers have frequently overlooked the wide range of variation exhibited by leaves on the same tree of a living

[1] Brongniart (81).
[2] Gardner (83), pl. xxv.

Gingko. There is a wide difference between the small entire leaves borne on fertile shoots and the larger ones with a shallow central incision, and between these and the leaves of which the lamina is divided into several comparatively narrow lobes by divisions extending almost to the petiole. The leaves with a large spreading and much dissected lamina are often found on young and vigorous shoots or on seedlings; these might well be included in a distinct species if found as isolated fossils.[1]

It has been customary to make use of Braun's generic name *Baiera*[2] or Unger's term *Jeanpaulia* for leaves of a *Ginkgo*-like habit, but having narrower or linear segments of the type represented in Pl. IX. Figs. 3–7. Such a generic distinction is no doubt, in some cases at least, purely artificial, but as it serves a useful purpose we may continue the custom, admitting that a distinctive generic name does not necessarily imply a distinction of great taxonomic importance. It is easy to obtain a series of fossil leaves exhibiting various transitional stages between the type, in which the lamina is entire, and such a form as that shown in Fig. 6, Pl. IX., where the lamina is reduced to forked acicular segments. The limits of the two genera, *Ginkgo* and *Baiera*, cannot therefore be accurately defined, but, speaking generally, the former name is applied to leaves with an entire lamina, or with a lamina divided into two or more comparatively broad segments, while the latter name implies leaves in which the segments vary in breadth from less than 1 mm. to 2 or 3 mm. in breadth, and may be usually described as linear.

1. Ginkgo digitata (Brongniart).

[Hist. vég. foss. p. 219, pl. lxi. *bis*, figs. 2 and 3, 1828.]

(Pl. IX. Figs. 1, 2, 9, and 10; Text-fig. 45.)

1828. *Cyclopteris digitata*, Brongniart, Hist. vég. foss. p. 219, pl. lxi. *bis*, figs. 2 and 3.
1829. *Sphenopteris latifolia*, Phillips, Geol. Yorks. p. 148, pl. vii. fig. 18.
1833. *Cyclopteris digitata*, Lindley & Hutton, Foss. Flor. vol. i. pl. lxiv.

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[1] For figures of several forms of leaves of the recent species, vide Seward & Gowan (00), pl. x. figs. 62–66, 70.

[2] Braun (43), p. 20.

1836. *Adiantites digitatus*, Göppert, Foss. Farrn. p. 217.
A. Huttoni, ibid.

1838. *Cyclopteris Huttoni*, Sternberg, Flor. Vorwelt, vii. p. 66.
C. digitata, ibid.

1841. *Cyclopteris Huttoni*, Göppert, Gatt. foss. Pflan. (v. and vi.), pls. iv., v. figs. 17–19.

1843. *Baiera digitata*, Braun, in Münster, p. 21.
B. Huttoni, ibid.

1846. *Cyclopteris digitata*, Dunker, Wealdenbildung, p. 9, pl. i. fig. 8; pl. v. figs. 5 and 6; pl. vi. fig. 11.

1848. ? *Cyclopteris digitata*, Bronn, Ind. Pal. p. 376.

1849. *Cyclopteris digitata*, Brongniart, Tableau, p. 105.
Baiera Huttoni, ibid.

1850. *Cyclopteris digitata*, Unger, Gen. spec. plant. foss. p. 94.
C. Huttoni, ibid.

1852. *Cyclopteris digitata*, Ettingshausen, Abh. k.-k. geol. Reichs. vol. i. Abth. 3, p. 12, pl. iv. fig. 2.

1853. *Cyclopteris digitata*, Andrae, Foss. flor. Sieben. p. 31.

1854. *Cyclopteris digitata*, Morris, Brit. Foss. p. 7.

1856. *Cyclopteris digitata*, Zigno, Flor. foss. Oolit. vol. i. p. 102.
C. Huttoni, ibid. p. 103.

1864. *Cyclopteris digitata*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76, pl. iv. fig. 6.

1868. *Cyclopteris incisa*, Eichwald, Leth. Ross. pl. iv. fig. 6.

1869. *Baiera digitata*, Schimper, Trait. pal. vég. vol. i. p. 423, pl. xliv. fig. 1.

1871. ? *Baiera multipartita*, Schenk, Palæontograph. vol. xix. p. 10, pl. xxiv. pp. 1–8.

1875. *Cyclopteris digitata*, Phillips, Geol. Yorks. p. 200, pl. vii. fig. 18.

1877. *Ginkgo digitata*, Heer, Flor. foss. Arct. vol. iv. (1), p. 40, pl. viii. fig. 1*a*; pl. x. figs. 1–6 (including the following varieties: *biloba*, *quadriloba*, *multiloba*, and *angustiloba*).
G. Huttoni, Heer, ibid. p. 43, pl. x. fig. 10; vol. iv. (2), p. 59, pl. v. fig. 1*b*; pl. vii. fig. 4; pl. x. fig. 8.

1878. *Ginkgo Huttoni*, Heer, ibid. vol. vii. p. 25, pl. vi. fig. 7.
G. integriuscula, Heer, ibid. p. 25, pl. vi. figs. 5 and 6.
Cf. *G. Jaccardi*, Heer, ibid. pl. lviii. fig. 20.

1881. *Ginkgo digitata*, Heer, Engler's Jahrb. vol. i. p. 11.
G. Huttoni, ibid. p. 12.

1882. ? *Ginkgo multinervis*, Heer, Flor. foss. Arct. vol. vi (1), pls. vi., viii., and ix.

1884. *Salisburia digitata*, Saporta, Pal. Franç. vol. iii. p. 294, pl. clx. figs. 1–5.
S. Huttoni, ibid. p. 299, pl. clix. figs. 4, 5; pl. clx. fig. 8.

1889. *Ginkgo digitata*, Yokoyama, Journ. Coll. Sci. Japan, vol. iii. p. 59, pl. xiii. fig. 2.

1890. *Ginkgo digitata*, Schenk, in Zittel, p. 264.

1892. *Ginkgo digitata*, Fox-Strangways, Tab. Foss. p. 138.
G. Huttoni, ibid.

1894. *Ginkgo digitata*, var. *integriuscula*, Bartholin, Bot. Tidss. vol. xix. p. 96, pl. iv. fig. 1.
G. Huttoni, ibid. p. 97, pl. iv. figs. 2 and 3.
1897. *Ginkgo Huttoni*, Bartholin, Dan. Geol. Anders. pl. B, fig. 11.
G. digitata, Nathorst, Flor. Spitzbergen, p. 15.
1900. *Ginkgo digitata*, Seward & Gowan, Annals Bot. vol. xiv. pls. ix. and x.
G. digitata, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 23, pl. ii. fig. 5.
Cf. *G. polaris*, Nathorst, Norwegian Polar Expedition, pt. iii. pl. i. fig. 8, etc.

Type-specimens. The type of Brongniart's figures is probably in the Paris Museum. The type-specimen named by Phillips *Sphenopteris latifolia* is in the York Museum.

Leaves with a long slender petiole, slightly expanded at the base and grooved on the upper surface, attached to either long or short shoots. The lamina may be either entire or repeatedly lobed, varying in shape from a broad fan-shaped form, with a straight base, or with the lower margin of the lamina making an acute angle with the petiole (e.g. Fig. 1, Pl. IX.), to a narrower wedge-shaped form, in which the lower edges of the lamina make an obtuse angle with the petiole (Fig. 10, Pl. IX.). Veins numerous, spreading, and branched dichotomously. The male flowers are similar in form to those of the recent species, the filaments of the anthers bearing two or more terminal elliptical or oval pollen-sacs. The female flowers are imperfectly known, but probably similar in type to those of *Ginkgo biloba*.

In the above diagnosis, which is necessarily incomplete, the flowers are not fully described, because we have no absolute proof of the actual connection of certain species of *Ginkgo* leaves with associated male flowers and seeds or fragments of female flowers. There is, however, every reason to believe that the flowers of some at least of the Mesozoic species of *Ginkgo* agreed in essentials with those of the recent species.

It will be seen from the above synonymy that I have included under *Ginkgo digitata* certain species which have usually been regarded as distinct. The chief reason for this diminution in the number of the specific names is to be found in the marked tendency to variation in leaf-form of the recent species. The deeply lobed lamina, such as that illustrated in Figs. 2 and 10, Pl. IX., has generally been regarded as characterizing a separate species, named by Sternberg *Cyclopteris Huttoni*, and referred to by

later authors as *Ginkgo Huttoni*; this fossil form may, however, be closely matched with the more deeply lobed leaves frequently met with on the recent species. While including both forms of leaf under one specific name, it may be convenient to distinguish the more deeply lobed type by adding the term *Huttoni* as marking a 'form' or variety of the species *G. digitata*.

Brongniart[1] defined the species *Cyclopteris digitata* as follows:—"*Cyclopteris* foliis petiolatis, semiorbiculatis, flabelliformibus, ad marginem lobatis, lobis contiguis cuneiformibus truncatis vel ad apicem sinuosis, nervis tenuissimis striæformibus æqualibus." Brongniart compares the leaves with those of *Trichomanes reniforme*.

The drawing given in Phillips' work (pl. vii. fig. 18) is far from accurate; it is impossible to detect in the specimen anything corresponding to the three small lobes shown at the base of the leaf. The type-specimen represents a typical example of a *Ginkgo* leaf with a divided lamina; it is twice the size of the drawing, as indicated in Phillips' figure. Göppert, like Brongniart and other authors, placed the *Ginkgo* leaves in a genus denoting a fern affinity. Braun included *Cyclopteris digitata*, Brongn., in his new genus *Baiera*, which he compared with *Marsilia*, on the strength of a supposed resemblance of what he took for reproductive structures to the sporocarps of that genus.

In the fourth volume of his *Flora fossilis Arctica*, Heer discussed the affinity of *Cyclopteris digitata*, Brongn., and allied Jurassic species, which he described from Spitzbergen; he pointed to certain characteristics in the venation of the lamina and to the grooved surface of the petiole of the fossil leaves as reasons for regarding the leaves as generically identical with those of *Ginkgo biloba*.[2] Heer also described specimens of male flowers and seeds associated with several of the fossil leaves, and these he naturally regarded, from their very close resemblance to the flowers of the recent species, as belonging to the plant which bore the leaves with which they were found in close association.

The species *Cyclopteris incisa*, described by Eichwald from Russia, is of the same form as some of the English *Ginkgo* leaves from the Yorkshire coast; it agrees closely with the example

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[1] Brongniart (28²), p. 219.

[2] Heer (77¹), p. 41.

shown in Fig. 1, Pl. IX., and still more closely with an unusually large leaf of *G. digitata* in the Manchester Museum.[1] Heer's species *G. integriuscula*, from Spitzbergen, is characterized by an entire lamina, but, as Nathorst points out and Heer has himself admitted, there are no good grounds for regarding this form as specifically distinct from *G. digitata*. In the York Museum there is a very good specimen of a *Ginkgo* leaf from East Yorkshire, agreeing in general shape with Fig. 1, Pl. IX., but differing in having a lamina which is practically entire.[2]

The Wealden leaves described by Dunker as *Cyclopteris digitata*, and afterwards by Schenk as *Baiera multipartita*, may possibly be specifically identical with the Lower Oolite *G. digitata*, but it is safer to suggest their identity rather than to regard it as well established. The wide range of *Ginkgo digitata* is shown by the references in the above list of synonyms; examples of this species have been recorded from Siberia, Spitzbergen, Franz Josef Land, Bornholm, England, Persia, Japan, and elsewhere. The Arctic distribution of *Ginkgo* in Upper Jurassic times has recently been extended by the discovery of several leaves named by Nathorst *Ginkgo polaris*[3]; some of them are very similar to *G. digitata*, and differ only in their smaller dimensions, which suggest an Arctic form of the English species.

Before dealing with the flowers which may possibly belong to *Ginkgo digitata*, we may briefly describe the fossil leaves represented in the Museum Collection.

39,211. Pl. IX. Fig. 1.

This unusually perfect specimen has a lamina 3·8 cm. deep and 6 cm. broad, with numerous and well-preserved forked veins. The upper part only of the petiole has been preserved. Cf. Brongniart's pl. vi. *bis*, fig. 2; also Eichwald, pl. iv. fig. 6. The veins are very clearly shown, and follow a course similar to that in the leaves of the recent species.

Oolitic Shale, Scarborough. *Bean Coll.*

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[1] For a figure of the Manchester specimen, vide Seward (00), pl. ii. fig. 5.
[2] For a figure of this species, vide Seward & Gowan (00), pl. x. fig. 54.
[3] Newton & Teall (97), pl. xxxviii.; Nathorst (00).

10,316. Pl. IX. Fig. 9.

A smaller example, similar to that of Fig. 1; 3·7 cm. in breadth and 2·8 cm. deep. Venation clearly shown.

Upper Shale, Scarborough. *Mantell Coll.*

Ginkgo digitata, forma *Huttoni*.

V. 3578. Pl. IX. Fig. 2.

This represents a more deeply lobed type, similar to the leaf figured by Lindley & Hutton as *Cyclopteris digitata*, but afterwards placed by Sternberg and others in a distinct species—*C. Huttoni*. If this form of leaf be compared with the more deeply dissected leaves of *G. biloba*, as for example the recent leaf figured by Lindley & Hutton in their plate xxvii. and those figured by Saporta and Gardner in their respective works, it will be seen that the more deeply divided lamina is in itself no sufficient reason for a separate specific designation. This type of leaf is represented by some examples approaching closely the form shown in Fig. 4, Pl. IX., which is referred to *Baiera Phillipsi*, Nathorst. Labelled by Bean *Cyclopteris digitata*.

Upper Shale, Scarborough.

V. 3580. Pl. IX. Fig. 10.

Another deeply lobed form, which can be matched exactly with some of the smaller leaves of the recent species. The lamina is 3 cm. broad and 2·7 cm. deep. This leaf occurs with several others on a large piece of rock; most of them exhibit a similarly lobed lamina, but others approach closely *Baiera Phillipsi* (Pl. IX. Fig. 4).

Other specimens:—**13,503** (broad segments), **24,755**, **39,215**, **40,468**, *G. digitata* (forma *Huttoni*), **V. 3300** (similar to **V. 3580**, Fig. 10, Pl. IX.), **V. 3579** (portions of several leaves), **11,019**, **39,212**, **40,546**.

Ginkgo digitata (flowers). Text-fig. 45.

Although we cannot speak with certainty as to the connection of any fossil flowers with this species, it is very probable that some imperfect examples of male flowers and isolated pollen-sacs met with in the English rocks may, as Nathorst first suggested, be presumably regarded as the flowers of this species.

In 1829 Phillips figured some small leaf-like bodies as "unknown leaves"; the original specimen, which is in the Cambridge Museum, reveals the identity of these bodies with some more perfectly preserved fossils in the Leckenby Collection, British Museum, and elsewhere, which Nathorst regarded as pollen-sacs probably belonging to *Ginkgo digitata.* On the label attached to Phillips' figured specimen Bean has written the following note from Brongniart:—"Appears to be a very curious plant, but the specimen is incomplete, so that I cannot form any opinion about it. 1838." On another specimen Nathorst wrote: "Male flowers of *Ginkgo digitata.*" A more perfect specimen in the Leckenby Collection,[1] to which Nathorst has referred in his notes on Jurassic plants in English Museums, shows a portion of a central axis from



FIG. 45.—Pollen-sacs of *Ginkgo* (? *G. digitata*). No. 39,320. (× 3.)

which are given off at right angles a few short and slender filaments, bearing elliptical bodies (pollen-sacs), either two or three together at their tips; some of them appear to be still in their original position, while others have fallen off the filaments. This fragment agrees with the male flowers of *G. biloba*, as also with the numerous and better preserved male flowers figured by Heer from Siberia and elsewhere, and leaves no doubt that Phillips' "unknown leaves" are pollen-sacs of *Ginkgo.* In most cases Heer simply refers to his specimens as male flowers of *Ginkgo*, and connects them with *G. Sibirica*, Heer, and other species; but some of the later examples which he describes are spoken of as species of *Antholithus.* We might refer the specimens of male flowers to such a genus as

[1] For a figure of this specimen, vide Seward & Gowan (00), pl. ix. fig. 28.

Androstrobus, but where there is so good a reason, as in this instance, for believing the flowers to belong to a definite plant, it is hardly necessary or advisable to introduce a separate designation.

The imperfect specimen from Franz Josef Land figured by Nathorst[1] as a male flower of *Ginkgo*, is hardly distinct enough for determination.

39,320. Text-fig. 45.

Numerous isolated pollen-sacs, about 5 mm. long, showing a median line indicating the longitudinal dehiscence. Fragments of the slender axis of the male flower are associated with the loose pollen-sacs.

This specimen is labelled by Bean "unknown leaves" (so called by Phillips in the description of his fig. 23, pl. vii.[2]); and by Nathorst, "male flowers of *Ginkgo digitata.*"

2. Ginkgo whitbiensis, Nathorst.

[Öfvers. k. Veten. Akad. Förhand. p. 74, 1880.]

(Pl. IX. Fig. 8.)

1880. *Ginkgo whitbiensis*, Nathorst, Berätt. p. 74.
1892. *Ginkgo whitbiensis*, Fox-Strangways, Tab. Foss. p. 138.

Type-specimen. British Museum (No. **39,331**).

Leaves smaller than in *Ginkgo digitata*; lamina deltoid in shape, deeply dissected into linear segments with acuminate or somewhat truncated tips.

The small form of leaf for which Nathorst suggested the name *Ginkgo whitbiensis* may be conveniently regarded as distinct from *G. digitata*, from which it differs in the smaller size of the lamina and in the somewhat more pointed segments. Some of the small *Ginkgo* leaves, recently described by Nathorst and by Newton & Teall, from Franz Josef Land,[3] may be compared with this type.

39,331. Pl. IX. Fig. 8.

A leaf considerably smaller than the typical *G. digitata*, with tapered segments traversed by prominent forked veins. A second

[1] Nathorst (00), pl. i. fig. 49.
[2] Phillips (75).
[3] Nathorst (00); Newton & Teall (97).

leaf of this type occurs in close proximity to the example figured, associated with *Czekanowskia Murrayana*, etc.

Genus BAIERA.

[Braun, in Münster's Beiträge, Heft vi. p. 20, 1843.]

1. **Baiera gracilis,** Bunbury, ex Bean MS.
2. **Baiera Lindleyana** (Schimper).
3. **Baiera Phillipsi,** Nathorst.

Braun defined his genus *Baiera* as follows:—

"Venæ primariæ frondis pluries dichotomæ; venæ secundariæ ac venulæ in areas hexagonales elongatis irregulariter confluentes; sporocarpia capsulæformia, ovalia pedunculata, ternata vel biternata."

This diagnosis does not apply in all respects—e.g. as regards venation characters—to species of *Baiera*, but subsequent work has demonstrated more satisfactorily the true character of Braun's genus.

The genus *Baiera* includes several species of Palæozoic and Mesozoic age, some of which are almost certainly near relatives of the maidenhair-tree. Braun,[1] the author of the genus, applied the name to some Triassic leaves which agree with *Ginkgo* in shape, but differ in possessing a lamina with more numerous and narrower segments. Braun and Schenk[2] included *Baiera* among the ferns, and it is not improbable that some of the species may be best compared with such recent ferns as *Actinopteris radiata*, Link, or with species of *Schizæa*, e.g. *S. dichotoma*, Sw., *S. elegans*, Sw., and others.

Valuable evidence as to the Gymnospermous nature of some types of the genus is afforded by examples of flowers and seeds described by Schenk,[3] Heer,[4] and other authors. Among Palæozoic leaves referred to *Baiera*, we have *Baiera virginiana*, Font. & Wh.,[5]

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[1] Braun (43), p. 20.
[2] Schenk (67).
[3] Ibid.
[4] Heer (76), p. 51.
[5] Fontaine & White (80), pl. xxxvii.

from the Permian of Virginia, *B. Raymondi*, Ren.,[1] from Charmoy, and some other species. The genus was probably most widely spread during the Jurassic period, but there is fairly strong evidence in favour of extending its range to the Palæozoic epoch. In considering the range of *Baiera* it is important to bear in mind the absence of any well-marked distinguishing features between some species of this genus and some of the more dissected forms of *Ginkgo* leaves. Among Jurassic leaves of the *Ginkgo* type—e.g. *G. digitata* (Brongn.) and *Baiera Phillipsi*, Nath.—it is easy to select a series illustrating a gradual transition from leaves with an entire lamina to those with a dissected lamina and linear segments, conforming in all respects to Braun's genus *Baiera*, and to leaves which some authors include in the genus *Jeanpaulia*.[2]

1. Baiera gracilis, Bunbury, ex Bean MS.

[Quart. Journ. Geol. Soc. p. 182, pl. xii. fig. 3, 1851.]

(Pl. IX. Figs. 3 and 5.)

1851. *Baiera? gracilis*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 182, pl. xii. fig. 3.
1854. *Baiera gracilis*, Morris, Brit. Foss. p. 3.
1856. *Cyclopteris gracilis*, Zigno, Flor. foss. Oolit. vol. i. p. 104.
1864. *Baiera gracilis*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1873. Cf. *Jeanpaulia longifolia*, Saporta, Pal. Franç. p. 464, pl. lxvii. fig. 1. *J. obtusa*, ibid. pl. lxvii. fig. 2.
1875. *Baiera gracilis*, Phillips, Geol. Yorks. p. 199, lign. 8.
1890. *Baiera gracilis*, Schenk, in Zittel's Handbuch, p. 262.
1892. *Baiera gracilis*, Fox-Strangways, Tab. Foss. p. 137.
1900. *Baiera gracilis*, Seward & Gowan, Annals Bot. vol. xiv. pl. x. figs. 6–8.

Type-specimen. The Bunbury Collection, Botanical Museum, Cambridge.

Leaf stalked, the lamina fan-shaped, divided into several forked linear segments, each traversed by a few veins. The petiole is long and narrow, branching at the summit into equal branches, which bifurcate repeatedly and spread out in a fan-shaped form; the ultimate segments are linear, and terminate in a more or

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[1] Renault (96), p. 138, fig. 51.
[2] Seward & Gowan (00), p. 138.

less blunt point. The breadth and number of the segments vary considerably in different leaves.

The plant to which Bunbury gave the name *Baiera gracilis* had previously been named by Bean *Schizopteris gracilis*, but the latter term was never published, and is quoted, therefore, as a manuscript name. Bunbury compares his species with *Cyclopteris Huttoni*, Sternb. (= *Ginkgo*), and sees no reason for removing these two species from the ferns; he quotes *Acrostichum peltatum* as a recent fern of similar habit. The leaves of *Baiera gracilis* differ but little from some of those usually referred to *Ginkgo Huttoni*, *Baiera longifolia* or *B. Phillipsi*, and *Solenites furcatus*; all exhibit the same general form, and are characterized by forked segments; in *B. gracilis* the segments are linear and narrower than in *G. Huttoni*, but broader than in the plant we have named *B. Lindleyana*.

Some of the Siberian leaves figured by Heer as *Ginkgo lepida*[1] are indistinguishable from *Baiera gracilis*; Heer's Greenland species, *Baiera incurvata*[2] and *B. Czekanowskiana*,[3] may also be compared with *B. gracilis*. A fragment described by Fontaine from the Potomac beds as *Baiera foliosa*[4] bears a resemblance to Bunbury's species, and a specimen figured by Schenk from China as *B. angustiloba*[5] is also not unlike the English type.

Some specimens of Bunbury's species appear to be identical with the Rhætic species *Baiera* (or *Jeanpaulia*) *Muensteriana* (Presl).[6] This probable identity, or at least striking resemblance, is illustrated by specimen **39,209** (Pl. IX. Fig. 3), which may be referred to as *B. gracilis*, forma *Muensteriana*.

The form of leaf represented by *Baiera gracilis*, Bunb., is one which was very widely distributed in Mesozoic times; in addition to the species already mentioned as possibly identical with this type, several others might be quoted, but in most cases the data are insufficient to enable us to do more than call attention to resemblances without necessarily implying specific identity. It is

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[1] Heer (80), vol. vi. (2), pl. v. fig. 3*a*.
[2] Heer (80), vol. vi. (3), pl. xiii. fig. 6.
[3] Heer (80), vol. vi. (2), pl. ii. figs. 1–3.
[4] Fontaine (89), pl. xciv. fig. 13.
[5] Schenk (83), pl. liii. fig. 1.
[6] Schenk (67), pl. ix.

probable that the short synonymy given for *Baiera gracilis* might be considerably extended without great risk of error. The number of fossil leaves described by Heer and other authors, which exhibit every stage in the transition from the obvious *Ginkgo* type to the narrow lobed *Baiera* forms, demonstrate the futility of attempting to draw definite lines between one species and another when we have only mere fragments to guide us.

39,208. Pl. IX. Fig. 5.

A large piece of rock with impressions of several leaves, which vary considerably as regards the number of linear segments. The example figured agrees with Bunbury's type-specimen, and represents a fairly common form of the species. The tips of the segments are obtusely pointed; in some of the leaves the segments are longer than as shown in Fig. 5 and less spreading, as in some of the examples of *Jeanpaulia Muensteriana* figured by Schenk. The longest leaf-stalk measures 7 cm. Specimens of *Baiera Lindleyana* occur in association with the leaves of *B. gracilis*. Labelled by Bean *Schizopteris gracilis*.

39,209. Pl. IX. Fig. 3.

In this example the segments are more numerous than in the type-specimen or in **39,208** (Pl. IX. Fig. 5), but the general habit of the leaf is similar to that of the specimens with few segments. The leaf is about 10 cm. broad, 4·5 cm. high. Cf. Saporta's figures of *Baiera Muensteriana*[1] and *B. gracilis*[2]; also Schenk's figures of *Jeanpaulia Muensteriana*.[3]

In each segment there are a few parallel veins, but these are not clearly shown. The practical identity of this form of leaf with that of *Jeanpaulia Muensteriana*, as figured by Schenk, may be expressed by speaking of such examples as that shown in Fig. 3 as *Baiera gracilis*, forma *Muensteriana*.

Scarborough. *Bean Coll.*

V. 2524. Labelled by Bean *Schizopteris gracilis*. One of the leaves of *Baiera gracilis* shown on this slab of rock has narrower

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[1] Saporta (84), pl. clvi. fig. 1; pl. clvii. figs. 1 and 2.
[2] Ibid. pl. clvii. fig. 4; pl. clviii.
[3] Schenk (67), pl. ix.

segments—rather less than 2 mm. in width—which serve to practically connect this species with *B. Lindleyana*.
Lower Shale, Scarborough.

10,376. A leaf with few and narrow segments, approaching *Baiera Lindleyana*, specimens of which occur on the same piece of rock with the larger leaves.
Lower Shale, Scarborough. *Mantell Coll.*

Other specimens:—**V. 3302, 10,318, 39,279, 39,280** (labelled by Bean *Sphenopteris longifolia*; associated with a male flower of *Pagiophyllum Williamsoni*).

2. Baiera Lindleyana (Schimper).

[Trait. pal. vég. vol. i. p. 683, 1869.]

(Pl. IX. Figs. 6 and 7; Text-fig. 46.)

1837. *Solenites? furcata*, Lindley & Hutton, Foss. Flor. vol. iii. pl. ccix.
1838. *Chondrites furcatus*, Sternberg, Flor. Vorwelt, vii. p. 103.
1843. *Baiera furcata*, Braun, in Münster's Beit. p. 21.
1848. *Solenites furcata*, Bronn, Ind. Pal. p. 1156.
1849. *Baiera furcata*, Brongniart, Tableau, p. 105.
1850. *Chondrites solenites*, Unger, Gen. spec. plant. foss. p. 19.
1854. *Solenites furcata*, Morris, Brit. Foss. p. 20.
1856. Cf. *Trevisania furcellata*, Zigno, Flor. foss. Oolit. vol. i. p. 23, pl. i. fig. 4*a*.
Chondrites solenites, ibid. p. 25.
1869. *Jeanpaulia Lindleyana*, Schimper, Trait. pal. vég. vol. i. p. 683.
1873. ? *Jeanpaulia laciniata*, Saporta, Pal. Franç. pl. lxvii. fig. 3.
1875. *Solenites furcata*, Phillips, Geol. Yorks. p. 199, lign. 7.
Baiera microphylla, ibid. p. 200, lign. 9.
1884. *Trichopitys Lindleyana*, Saporta, Pal. Franç. vol. iii. p. 266, pl. clv. figs. 1 and 2.
1892. *Solenites furcata*, Fox-Strangways, Tab. Foss. p. 141.
Baiera microphylla, ibid. p. 137.
1899. ? *Czekanowskia nervosa*, Fontaine, U.S. Geol. Survey, p. 685, pl. clxix. figs. 1 and 2.

Type-specimen. The type-specimen of *Baiera microphylla*, Phill., is in the Leckenby Collection, Cambridge (No. 389).

The specimens on which Lindley & Hutton founded this species, were obtained by "Mr. Williamson, junr.," from Haiburn Wyke, near Scarborough. They made use of the generic name *Solenites*

"rather for the sake of giving the plant a station and a name," than because they "had any reason for considering it of the same nature as *S. Murrayana*, further than its similarity of appearance." The *Solenites furcata* of Lindley & Hutton differs from *S. Murrayana* of these authors in consisting of a definite petiole, which divides into several regularly forked and narrow branches, disposed in such a way as to form a broadly triangular stalked leaf, having very slender acicular segments. Braun referred *Solenites furcata*, L. & H., to his new genus *Baiera*, and Brongniart, in his *Tableau*, mentions this species under Braun's name as *Baiera furcata*, but, in view of the distinct form of the English plant, he considers *Psilotites* a more suitable generic designation. Saporta at first included *Solenites furcata* in the genus *Jeanpaulia*, and regarded it as a fern. Schimper[1] had previously altered the name given by Lindley & Hutton to *Jeanpaulia Lindleyana*, erroneously including *Sphenopteris longifolia*, Phillips, as a synonym. At a later date Saporta substituted his genus *Trichopitys*, founded in 1875, and classed the plant among the Conifers in the tribe *Salisburiæ*, reproducing the figures of Lindley & Hutton to illustrate the similarity between the Oolitic species and the Permian species *Trichopitys heteromorpha*. The resemblance between the two plants is not, however, very close, and it is doubtful whether they should be referred to the same genus. Nathorst expresses doubt as to the advisability of separating *Solenites furcata* from the genus *Baiera*. Solms-Laubach,[2] on the other hand, favours the generic identity of the two plants included by Lindley & Hutton in their genus *Solenites*. Solms speaks of *Solenites furcatus* as "known only from some scanty remains in not too good a state of preservation." The examples in the Leckenby Collection, including both young and fully expanded leaves, are well-preserved impressions, and lend support to Braun's view that *Baiera* is the most appropriate genus. *Solenites furcata* differs from such plants as Bunbury named *Baiera gracilis*, and Schenk and Heer referred to *Baiera Muensteriana* (Presl), only in the narrower form of the segments, and shows no differences sufficient to justify the adoption of another generic term. The specific name *Lindleyana* has been retained, as the most

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[1] Schimper (69), p. 683.
[2] Solms-Laubach (91), p. 193.

convenient designation; the original name *furcata* of Lindley & Hutton was adopted in 1843 by Braun, who called the plant *Baiera furcata*, but in 1865 Heer named some fragments of leaves from Keuper beds of Switzerland *Sclerophyllina furcata*, and afterwards substituted the generic name *Baiera*, possibly in ignorance of the use of the same name by Braun in 1843.

Baiera Lindleyana may be compared with *B. spetsbergensis*, Nath.,[1] from the Upper Jurassic of Advent Bay, also with *B. tenuifolia*, Johnst.,[2] from the Jerusalem Coal-basin of Tasmania.



Fig. 46.—*Baiera Lindleyana* (Schimper). No. 39,283. (Nat. size.)

V. 3682. Pl. IX. Fig. 6.

Similar in form to *Baiera gracilis*, except in the narrower and more frequently branched segments. The tips of the segments are obtusely pointed as in *B. gracilis*. The Leckenby Collection, Cambridge, contains some specimens of *B. Lindleyana* in which the narrow segments are more widely spread, giving the leaf a broader form similar to that of *B. gracilis*, as shown in Pl. IX. Fig. 3.

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[1] Nathorst (97), pl. iii. figs. 6–12.
[2] Johnston (87), pl. xvi. fig. 8.

39,208. Pl. IX. Fig. 7.

This example occurs on the same slab with the leaf of *B. gracilis* represented in Fig. 5; it has segments intermediate in breadth between **V. 3682** (Fig. 6) and the narrower forms of *B. gracilis*.

39,283. Text-fig. 46.

A tuft of partially expanded leaves similar to *B. microphylla* (no doubt a young leaf of *B. Lindleyana*), as figured by Phillips. This specimen is practically identical with some of the fossils figured by Heer as examples of *Czekanowskia*.

3. Baiera Phillipsi, Nathorst.

[Öfvers. k. Veten. Akad. Förhand. p. 76, 1880.]

(Pl. IX. Fig. 4; Text-fig. 47.)

1829. *Sphenopteris longifolia*, Phillips, Geol. Yorks. p. 148, pl. vii. fig. 17.
1864. *Baiera longifolia*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
Cyclopteris digitata, var. *major*, Schenk, Palæontograph. pl. xlix. fig. 2.
1875. *Cyclopteris longifolia*, Phillips, loc. cit. p. 200, pl. vii. fig. 17.
1880. *Baiera Phillipsii*, Nathorst, Berättelse, p. 76.
1885. ? *Salisburia lepida*, Dawson, Trans. R. Soc. Canada, pl. ii. fig. 2.
? *Baiera longifolia*, ibid. pl. ii. fig. 5.
1892. *Baiera longifolia*, Fox-Strangways, Tab. Foss. p. 137.

Type-specimen. York Museum. (Text-fig. 47.)

The specimen on which Phillips founded the species *Sphenopteris longifolia* is shown in Text-fig. 47. If this drawing, which was carefully made from the type-specimen, be compared with Phillips' figure, it will be seen to bear a somewhat closer resemblance to a leaf of the *Baiera* type than is suggested by the original illustration. The example shown in Fig. 4, Pl. IX., is practically identical with the type-specimen. There is but little difference between the present type of leaf and some of the more deeply dissected and narrower lobed forms of *Ginkgo digitata* (of the shape usually referred to *Ginkgo Huttoni*) on the one hand, and *Baiera gracilis* on the other. It is convenient, however, to retain a definite specific name for this form of leaf, with its linear and bluntly terminated segments, as it constitutes a fairly distinctive type. The specific name *longifolia* was applied by Pomel to a leaf of somewhat similar but not identical form, which he named

Dicropteris longifolia; Pomel's plant was subsequently spoken of by Heer and other authors as *Baiera longifolia.*

To avoid confusion between Phillips' English plant and Pomel's species, Nathorst proposed to name the former *Baiera Phillipsi*, a name which may well be adopted. It is true that Phillips used the specific name *longifolia* several years before Pomel applied the same term to a distinct plant, but the long-established use of *Baiera longifolia* in Pomel's sense renders it advisable to adopt the new name *Phillipsi* for the English species.

Baiera Phillipsi agrees closely with some forms of *Ginkgo sibirica* and *G. lepida* as described by Heer from northern latitudes.

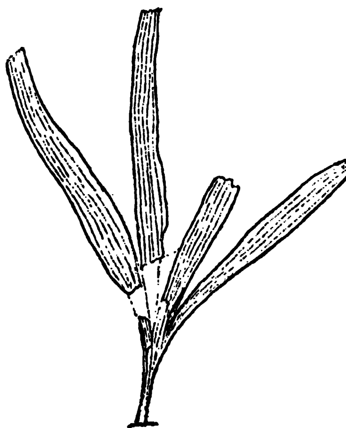


Fig. 47.—*Baiera Phillipsi*, Nath. [Type-specimen of Phillips (Pl. VII. Fig. 17), York Museum.] (Block lent by the University Press, Cambridge.)

A comparison may be made also with *Ginkgo sibirica* [1] as figured by Geyler from Japan.

The Rhætic leaves figured by Schenk [2] as *Baiera tæniata* bear a close resemblance to *B. Phillipsi.*

V. 3301. Pl. IX. Fig. 4. A single leaf occurring with several others of the same type on a large slab of rock. This specimen is precisely similar to the type-specimen of *Sphenopteris longifolia*,

[1] Geyler (77), pl. xxxi. fig. 6.
[2] Schenk (67), pl. v. fig. 2.

Phillips (Text-fig. 47). The leaf measures 5·5 cm. in length, and 5·5 in breadth.

Yorkshire. *Purchased.*

Text - fig. 47. (Type - specimen of Phillips' *Sphenopteris longifolia*; in the York Collection.) This species, not quite correctly figured by Phillips, is of the same type as **V. 3301** (Pl. IX. Fig. 4). Length of leaf 6·5 cm.

Upper Shale, Gristhorpe.

V. 3301. Narrow leaves, often with four segments, which may be broader than in the leaf shown in Fig. 4, Pl. IX. Cf. *B. gracilis* (Pl. IX. Fig. 5).

39,210. This affords an example of a leaf intermediate between the typical *B. Phillipsi* and *Ginkgo digitata*, forma *Huttoni*, as shown in Pl. IX. Figs. 2 and 10. The lamina is more deltoid in shape, and narrower than in such a leaf as that shown in Fig. 2, Pl. IX., but a comparison of the more broadly lobed forms placed in the species *B. Phillipsi* with some examples of *Ginkgo digitata*, forma *Huttoni*, leads to a strong suspicion that no satisfactory specific distinctions can be drawn between the various forms of leaves from the Lower Oolite rocks referred to the genera *Ginkgo* and *Baiera*.

Scarborough. *Bean Coll.*

Genus BEANIA.

[Carruthers, Geol. Mag. vol. vi. p. 1, 1869.]

The genus *Beania* was instituted by Carruthers in 1869 for a specimen from Gristhorpe, and diagnosed as follows:—

"Female fruit composed of scales arranged in loose spikes; scales stalked and peltate, supporting two ovoid sessile seeds, one on each side of the pedicel."

The general structure of *Beania* is very similar, as Carruthers pointed out, to that of the female flower of the Cycadean genus *Zamia*, except that the individual carpophylls are farther apart than in the recent species. If we imagine the internodes of the axis of a *Zamia* strobilus considerably elongated, we have a structure

closely resembling that of *Beania*. The affinity of the genus is considered at length in the account of the species *B. gracilis*. Some imperfect fragments recently described by Shirley from Ipswich, Queensland, as *Beania geminata*, are too indefinite to be determined.[1]

Beania gracilis, Carruthers.

[Geol. Mag. vol. vi. p. 1, pl. iv. fig. 1, 1869.]

(Pl. IX. Fig. 11.)

1835. *Sphæreda paradoxa*, Lindley & Hutton, Foss. Flor. vol. iii. pl. clix. fig. 2.
1849. *Sphæreda paradoxa*, Brongniart, Tableau, p. 105.
1850. *Sphæreda paradoxa*, Unger, Gen. spec. plant. foss. p. 520.
1864. *Sphæreda paradoxa*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1869. *Beania gracilis*, Carruthers, Geol. Mag. vol. vi. p. 1, pl. iv. fig. 1.
1870. *Beania gracilis*, Schimper, Trait. pal. vég. vol. ii. p. 206.
1872. *Beania gracilis*, Balfour, Palæont. Botany, p. 82, pl. ii. fig. 2.
1875. *Sphæreda paradoxa*, Phillips, Geol. Yorks. p. 233, pl. viii. fig. 2, lign. 68.
1875. *Beania gracilis*, Saporta, Pal. Franç. vol. ii. pp. 59, 63, pl. lxxvii. fig. 3.
1881. *Beania gracilis*, Renault, Cours foss. bot. vol. i. p. 58, pl. vi. fig. 5.
1885. *Beania gracilis*, Zigno, Flor. foss. Oolit. vol. ii. p. 153.
1892. *Beania gracilis*, Fox-Strangways, Tab. Foss. p. 137.
1898. *Zamiostrobus* (*Beania*, Carr.), Potonié, Lehrbuch, p. 278, fig. 274.
1900. *Beania gracilis*, Seward & Gowan, Annals Bot. vol. xiv. p. 143.

Type-specimen. No. **45,040**, British Museum (Pl. IX. Fig. 11). Type of Phillips' fig. 2, pl. viii. (*Geol. Yorks.*), in the York Museum. Type of Lindley & Hutton, in the Oxford Museum.

A central, fairly stout woody axis, bearing scattered and loosely disposed secondary axes at right angles to the main axis; these secondary axes, which are probably of the nature of carpophylls, have the form of slender pedicels terminating in a peltate distal expansion, on the inner side of which are borne two oval or subspherical seeds with a fleshy outer coat.

The original diagnosis given by Carruthers is as follows:—"Axis of the female inflorescence slender; scales or slender stalks placed

[1] Shirley (98), pl. xx. p. 16.

at right angles to the axis, peltate, apex of the scale small, scarcely covering the ripe seeds; seeds sessile, ovoid, slightly acuminate at the apex, symmetrically arranged on the two sides of the pedicel, reflexed."

The author of the species points out the close resemblance of *Beania gracilis* to the female flower of the Cycadean genus *Zamia*; it agrees with such a strobilus as that of *Z. muricata*, Willd. (figured by Carruthers), "except that the apices of the scales are not adpressed, but the scales are scattered over the axis so as to form a very loose spike."

The two specimens figured by Lindley & Hutton in 1835 as *Sphæreda paradoxa* may possibly belong to the same species, but the fossil shown in fig. 1 of the *Fossil Flora* has a much broader axis and apparently smaller seeds than that shown in fig. 2. The latter, as Carruthers notices in his paper, is identical with *Beania gracilis*; I have not been able to find the original specimen of fig. 1, and without more evidence than is afforded by the drawing it is impossible to be certain as to its real nature. It may represent a flower of similar form to that of *Beania gracilis*, but specifically distinct. Lindley & Hutton express no definite opinion as to the nature of the fossils which they name *Sphæreda paradoxa*.

In the third edition of Phillips' *Geology of Yorkshire* a figure is given of a specimen identical with Carruthers' type, and the opinion expressed that it "may possibly be the rhizome of a fern with young fronds in the circinate condition." [1]

Schimper classes *Beania gracilis* among the Cycads, and suggests that the greater elongation of the internodes between the carpophylls, as compared with the more closely packed carpophylls of recent Cycads, may be due, in part, to growth in length after fertilization of the ovules.[2] This is hardly likely; the looser habit of the flower is no doubt an original character, and one which forms an interesting peculiarity of this Jurassic species. The suggestion of Saporta that this loose habit of *Beania gracilis* may be due to the fall of some of the carpophylls cannot be accepted; an examination of several specimens of this species enables me to assert that there is no evidence to support such a view.[3]

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[1] Phillips (75), p. 233.
[2] Schimper (70), p. 206.
[3] Saporta (75), p. 59.

Single seeds, like that figured by Phillips as a 'winged seed,' are not uncommon; there is no trace of a wing in the example figured by Phillips (original specimen in the York Museum), but the coat is considerably wrinkled, a character well marked in *Beania* seeds, and pointing to a thick fleshy integument such as that of the seeds of the recent genus *Cycas*.

It is difficult to decide by what Jurassic plant *Beania gracilis* was borne. Carruthers and other authors compare the flower with those of *Zamia* and other recent Cycads, and would presumably connect it with one of the numerous Cycads of Lower Oolite age which bore pinnate Cycadean fronds. So far as we know, the abundant Cycadean fronds belonged to plants with Bennettitean flowers; this is, I believe, proved to be the case in *Zamites gigas* (*Williamsonia gigas*), which bore the well-known *Williamsonia* type of flower; and it is very probable that the plant with the common fronds described by Lindley & Hutton as *Pterophyllum pecten* bore the flowers known as *Williamsonia Leckenbyi*, Nath. The Cycadean trunks from Maryland and Dakota in America, and the species known as *Bennettites Gibsonianus* of England, also the various *Bennettites* stems of Italy and elsewhere, produced floral structures very different from those of recent Cycads, and hardly comparable to such a type as that of *Beania gracilis*. We have, indeed, no satisfactory instance of a female Cycadean flower of Mesozoic age which can be reasonably connected with a plant bearing Cycadean foliage. The splendid Cycadean fronds which Heer has figured from the Cretaceous of Greenland as *Cycas Steenstrupi*,[1] is represented as associated with a fossil bearing a distinct resemblance to a carpophyll of the *Cycas* type; but an examination of the type-specimen in the Copenhagen Museum convinced me that the drawing of the supposed carpophyll does not accurately represent the facts. There is nothing on the slab containing the well-preserved Cycadean frond which can be reasonably compared with the carpel of *Cycas*. It is true there are a few stems, such as *Cycadeoidea gigantea*, Sew., which show no trace of Bennettitean flowers, but these are exceptional, and it must be admitted that such evidence as we have points to the conclusion that the majority of the Jurassic and Lower Cretaceous Cycads

[1] Heer (82), pl. v.; Potonié (99), p. 277, fig. 271.

were members of the Bennettiteæ, and did not conform in the characters of their reproductive organs to the existing members of the Cycadaceæ.

Is it possible, therefore, that *Beania gracilis* may have belonged to *Ginkgo* or some other member of the Ginkgoaceæ? We are familiar with male flowers in the Yorkshire rocks which agree with those of the maidenhair-tree, and in all probability were borne by species of *Ginkgo*, but as yet we have no evidence of the existence in Britain of female flowers of the modern *Ginkgo* type. Heer has described a few fragments from the Arctic regions, recalling the female flowers of *Ginkgo biloba*, but no satisfactory specimens are known. There is, indeed, a considerable difference between *Beania gracilis* and the female flowers of *Ginkgo* as they exist at the present day, but it is conceivable that the Mesozoic representatives of this genus, which exhibits so many points of contact with the Cycads, may have possessed reproductive organs more nearly related to those of recent Cycads than is the case with the surviving species. The male flowers of both fossil and recent Ginkgos consist of a central axis, bearing loosely disposed stamens, and are constructed on the same plan as *Beania gracilis*. The usual and normal female flowers of *Ginkgo biloba* consist of a strong axis bearing two terminal sessile ovules, but it is not uncommon to find examples in which the main axis bears several ovules, irregularly arranged and separated by fairly long internodes, borne on slender pedicels inclined at a considerable angle to the stouter central axis. Such abnormal flowers are of importance as at least showing a possible variation in the structure of the female reproductive shoot, and they afford a nearer approach to the type represented by *Beania*. The agreement is by no means perfect; in the *Ginkgo* flowers the ovules are terminal, and the apex points outwards, while in *Beania* they are attached to the inner side of a peltate expansion of the carpophyll. But this is a difference insufficient to invalidate a comparison. If we imagine the ovules of *Ginkgo* turned through an angle of 180° we should have the collar-like envelope occupying the same position as the peltate expansion in *Beania*. Some of the abnormal flowers of *Ginkgo*, such as those figured by Fujii,[1] and one recently figured by Miss Gowan and myself, approach more closely

[1] Fujii (96).

to the *Beania* type, and it is not improbable that these examples indicate ancestral features, as Čelakovský[1] has suggested. Without wishing to overstrain such arguments as may be adduced in favour of this view, we prefer to regard *Beania gracilis* as a female flower, which was more probably borne by a plant belonging to the Ginkgoaceæ than by a member of the true Cycadaceæ.

A type of flower similar to *Beania* has been described by Nathorst as *Zamiostrobus stenorachis*, from the Rhætic plant-beds of Scania.[2]

48,040. Pl. IX. Fig. 11; and Carruthers, 1869, pl. iv. fig. 1.

The main features of the type-specimen are well shown in Carruthers' drawing, but the central axis and the wrinkled seeds are rather more clearly reproduced in Fig. 11, Pl. IX.

Gristhorpe, near Scarborough.

13,522 and **13,523.** Single seeds with wrinkled testa.

Lower Shale, Cloughton.

? GINKGOACEÆ.

Genus CZEKANOWSKIA.

[Heer, Flor. foss. Arct. vol. iv. (2), p. 65, 1877.]

Heer places the genus *Czekanowskia* among the Coniferæ, and defines it as follows:—

"Folia numerosa in ramulo abbreviato caduco fasciculato, subulata, rigida, dichotoma, squamis compluribus persistentibus circumdata. Flores feminei racemosi. Fructus pedunculo brevi insidens, nuculis duabus valde approximatis."

The long and narrow needle-like leaves, originally placed by Lindley & Hutton[3] in the genus *Solenites* and compared by them with the recent *Isoetes*, are considered by Heer to belong to

[1] Čelakovský (90).
[2] Nathorst (75), pl. xiii.
[3] Lindley & Hutton (34), pl. cxxi.

a *Ginkgo*-like tree in which the short shoots were deciduous. The form of the needles suggests a comparison with *Pinus*, *Larix*, or *Cedrus*, but the distinct forking in several of the Siberian examples described by Heer led that author to cite the maidenhair-tree (*Ginkgo*) as the more probable type with which to compare the fossils. In some of the more perfect specimens the tuft of long needles is enclosed at the base by a few small scale-leaves, as in the short shoots of *Pinus* and *Larix*. Several of Heer's specimens exhibit numerous oval swellings on the leaves, which it is suggested may possibly represent spores; but if the plant is a Conifer, and not a Vascular Cryptogam, it is possible, he suggests, that these swellings are the result of the ravages of a fungus.

The frequent association of small seeds with the leaves of *Czekanowskia* led Heer to regard the two as parts of the same plant. The two Siberian species instituted by Heer, *Czekanowskia rigida* and *C. setacea*, closely resemble one another, and it is, I believe, impossible to separate the two forms by any satisfactory differences.

In 1873 Saporta[1] included *Solenites* under Unger's genus *Jeanpaulia*; but in a later work[2] both *Jeanpaulia* and *Solenites* are transferred to Saporta's genus *Trichopitys*, founded on a Permian plant, *T. heteromorpha*. Saporta refers more particularly to the type named by Lindley & Hutton *Solenites furcata*. By most authors, such specimens as those originally named by Lindley & Hutton *Solenites Murrayana* are placed in the genus *Czekanowskia*, and referred to the Coniferæ. Schimper,[3] on the other hand, includes *Solenites Murrayana* in the genus *Isoetes*. The form of the leaves and their occurrence in tufts lend support to the comparison with this genus, but the occurrence of the scale-leaves forms a point of resemblance to coniferous shoots. Solms-Laubach includes *Solenites Murrayana*[4] as a possible member of the Isoeteæ, but expresses considerable doubt as to its true position; he points out the desirability of examining the structure of the epidermis to ascertain if stomata are present, a character, he adds, which would strengthen the comparison with *Czekanowskia*. The thin carbonaceous film representing the needle-like leaves of *Solenites*

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[1] Saporta (73), p. 461.
[2] Ibid. (84), p. 263.
[3] Schimper (70), p. 75.
[4] Solms-Laubach (91), p. 192.

frequently peels off the surface of the rock, and may be readily cleared for microscopical examination by means of Schulze's macerating solution. Several pieces of leaf have been prepared in this way, and in some instances rendered more distinct by staining with safranin; the outlines of the epidermal cells stand out clearly, and rows of stomata, with oval guard-cells, extend along the length of the needles.

The form of the cells is shown in the small piece of cuticle represented in Fig. 48; the fragment is not large enough to demonstrate the occurrence of numerous stomata in rows, but if a strip of leaf be carefully prepared and mounted, the manner of occurrence of the guard-cells is at once apparent. In the majority

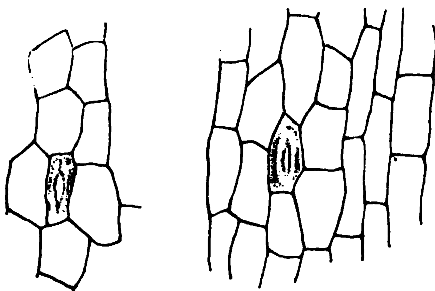


Fig. 48.—Part of the epidermis of *Czekanowskia Murrayana* (L. & H.), showing stomata.

of the species of *Isoetes* there are very few or no stomata, but in the land-forms, *I. Duriæi*, Bory, and *I. Hystrix*, Bory, stomata are abundant.[1] An examination of a leaf of the latter species reveals about four rows of stomata which occur over two large air-spaces; but the resemblance of the epidermal cells to those of *Solenites* is much less striking than in the case of coniferous needles. I have no hesitation in expressing the opinion that the structure of these Jurassic leaves agrees most closely with that of the needles of recent Conifers, and affords confirmatory evidence in favour of classing *Solenites* or *Czekanowskia* among the Coniferæ. The examination of the epidermal cells of *Solenites* (*Czekanowskia*) led

[1] Baker (87), p. 124.

Schenk to refer the genus to the Coniferæ rather than to the Isoetaceæ.[1]

We have as yet no absolute proof of any organic connection between the reproductive organs described by Heer and the *Czekanowskia* leaves, but the evidence, so far as it goes, favours the view that needles and seeds belong to the same plant.

The surface of the shale from the Yorkshire plant-beds is occasionally covered with an accumulation of the fine grass-like leaves of *Czekanowskia*, reminding one of the crowded needles carpeting the ground in a pine forest; some of the Siberian specimens are met with in similar profusion on the surface of the rock, and in the New Jersey Amboy clays a species of *Czekanowskia* occurs in equal abundance.[2]

Several authors have represented *Czekanowskia* leaves as occasionally dichotomously branched, a character in favour of a comparison with *Baiera* and the Ginkgoaceæ; among the numerous examples of the leaves of *Czekanowskia Murrayana* that I have examined, no absolutely certain case of branching was found. The long unbranched leaves of *Czekanowskia* remind one of the needles of *Pinus longifolia*, Salisb., and other long-leaved pines, but the branched type of leaf met with in some forms of the fossil genus is not in accord with a comparison between *Czekanowskia* and the Abietineæ. We may for the present regard this genus as a Conifer of doubtful affinity, and as possibly a member of the Ginkgoaceæ.

Czekanowskia Murrayana (Lindley & Hutton).

[Fossil Flora, vol. ii. pl. cxxi. 1834.]

(Text-figures 48–50.)

1829. *Flabellaria? viminea*, Phillips, Geol. Yorks. pp. 148 and 154, pl. x. fig. 12.
1834. *Solenites Murrayana*, Lindley & Hutton, Foss. Flor. vol. ii. pl. cxxi.
1848. *Solenites Murrayana*, Bronn, Ind. Pal. p. 1156.
1849. *Isoetes Murrayana*, Brongniart, Tableau, p. 105.
1850. *Isoetes Murrayana*, Unger, Gen. spec. plant. foss. p. 226.
1854. *Solenites Murrayana*, Morris, Brit. Foss. p. 20.

[1] Schenk (67), p. 57.
[2] Newberry (95), pl. ix. fig. 16.

1856. *Isoetites Murrayana*, Zigno, Flor. foss. Oolit. vol. i. p. 216.
1864. *Solenites Murrayana*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1870. *Isoetites Murrayana*, Schimper, Trait. pal. vég. vol. ii. p. 75.
1875. *Solenites Murrayanus*, Phillips, Geol. Yorks. p. 198, pl. x. fig. 12.
1877. *Czekanowskia rigida*, Heer, Flor. foss. Arct. pls. v. and vi. (*pars*).
C. setacea, ibid.
1885. ? *Pinus suskwaensis*, Dawson, Trans. Roy. Soc. Canada, pl. ii. fig. 6.
1892. *Solenites Murrayana*, Fox-Strangways, Tab. Foss. p. 138.
1895. Cf. *Czekanowskia capillaris*, Newberry, U.S. Monograph, xxvi. p. 61, pl. ix. figs. 14–16.
1896. *Czekanowskia rigida*, Hartz, Med. om Grönland, pls. xvii., xviii.
? *C. setacea*, ibid. pl. xvii.
1900. Cf. *Czekanowskia*, sp., Nathorst, Norwegian Polar Exped. pl. i.

The name *Flabellaria ? viminea*, applied by Phillips to an imperfect specimen of *Czekanowskia Murrayana*, never came into general use, and, in spite of the few years' priority of Phillips' term, it is better to adopt the better known name of Lindley & Hutton, by whom the plant was first described. A specimen in the Whitby Museum (No. 2493) labelled *Flabellaria viminea* is possibly the type of Phillips.

The type-specimen of Lindley & Hutton, obtained from Gristhorpe Bay, was compared by these authors with *Isoetes* and *Pilularia*, also with grasses and other monocotyledons. The bladder-like swellings shown in their figure are no doubt due to the partial peeling off and separation of the carbonaceous film from the surface of the shale; no definite swellings like those represented in the fossil flora can be detected in the specimen. Their drawing of the epidermal cells does not afford any indication of the occurrence of stomata, but in all the leaves of which I have examined fragments under the microscope stomata are abundant (Fig. 48).

In the third edition of the *Geology of the Yorkshire Coast*, *Solenites Murrayana* is compared with the more slender examples of *Baiera gracilis*.

A comparison of several specimens of Heer's two Siberian species, *Czekanowskia rigida* and *C. setacea*, in the Museum Collection, leads me to regard some of the examples of both these 'species' as identical with the type-specimen of Lindley & Hutton (Fig. 49); others differ from the type in their greater frequency of the dichotomous branching of the individual leaves, and agree more closely with the specimens named by Lindley & Hutton

Solenites furcata.[1] Williamson pointed out, in a note to Lindley, that the numerous needles of *Solenites Murrayana* occasionally cover the surface of a bed of shale; this manner of occurrence is illustrated by specimens in the Leckenby Collection, Whitby

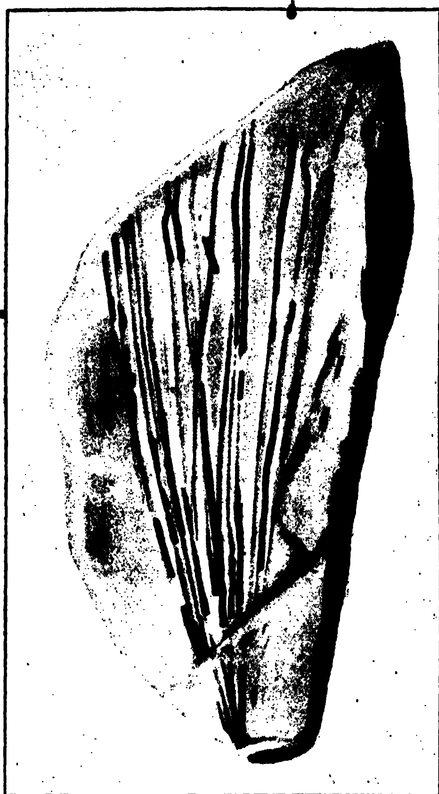


Fig. 49.—*Czekanowskia Murrayana* (L. & H.). Type-specimen of Lindley & Hutton (pl. cxxi.). No. V. 3685. (Nat. size.)

Museum, and elsewhere, and the same profusion of needles is seen in some of the Siberian specimens. In most of the English examples, where it is possible to trace the needles for some

[1] Lindley & Hutton (37), pl. ccix.

distance, there is no indication of forking, but in a few cases there appear to be indications of dichotomy. Nathorst, in a letter to Heer,[1] expressed the opinion that the leaves of the English examples were unbranched, but, as he pointed out, there is considerable difficulty, owing to the crowding of the leaves, in tracing a single leaf throughout its entire length. In Heer's specimens the needles are often single, and the usual absence of forking in the Yorkshire specimens is no serious obstacle to their identity with some of the Siberian fossils. As the name given by Lindley & Hutton is much older than those of Heer, and seeing that we have the type-specimen of *Solenites Murrayana* before us, it is probably the better plan to retain the older specific name, including under that designation some of the examples figured by Heer as *Czekanowskia rigida* and as *C. setacea.* The generic name *Czekanowskia*, which has come into general use, may be substituted for *Solenites.*

The fragmentary nature of the specimens of *Czekanowskia*, and the wide distribution of the genus in rocks of various ages, render an accurate specific determination practically impossible. In the English specimens we seldom find any trace of the scale-leaves or the very short axis which bears the needles, and the resemblance of isolated needles alone is of little value as an index of identity or close affinity. Such a fossil as Nathorst[2] has figured from the Rhætic beds of Stabbarp in Scania as *Czekanowskia rigida* appears identical with some of the Yorkshire specimens, but it would be rash to definitely include the Swedish and English examples in one species.

Type-specimen. The type-specimen of Lindley & Hutton is No. 3685 in the British Museum Collection. (Text-fig. 49.)

Needle-like leaves borne in tufts on deciduous short shoots, surrounded at the base by small imbricate scale-leaves; the foliage-leaves usually about 1 mm. in breadth or somewhat narrower, and reaching a length of over 17 cm. The needles are in most cases unbranched, but occasionally forked; the epidermis consists of rectangular cells slightly longer than broad; numerous stomata occur in longitudinal rows, separated by a few rows of epidermal cells without stomata.

[1] Heer (77^2), pls. v. and vi.
[2] Nathorst (86), p. 96, pl. xx. fig. 6.

Our knowledge of the organs of reproduction is hardly sufficient to enable us to diagnose the flowers or seeds. No well-marked veins can be detected on the leaves, but the surface is finely striated; in all probability the substance of the leaf was too thick to allow of the slender veins being visible externally.

V. 3685. Text-fig. 49. Also Lindley & Hutton, pl. cxxi. A.

Several imperfectly preserved leaves converging towards a supporting axis, which is not preserved. The bladder-like swellings



Fig. 50.—*Czekanowskia Murrayana* (L. & H.). No. V. 3684. (Nat. size.)

represented in the figure of the *Fossil Flora* are not present in the specimen, but no doubt the uplifted pieces of the lamina have become detached from the surface of the shale since the original drawing was made.

V. 3684. Text-fig. 50. This is one of the few specimens which shows any trace of the short axis and the scale-leaves; the short leaf bent downwards close to the axis may be a detached scale-leaf, as figured in similar specimens by Heer.

V. 3686. Another smaller specimen showing the short and thick axis of the short shoot; but the details are not clear.

V. 3687. Needles less than 1 mm. in width; the lamina showing here and there a tendency to peel off the shale, suggesting the swellings represented by Lindley & Hutton.

39,282. Tufts of long and slender needles, in some places showing apparent indications of forking; but in no case is it possible to be certain that forking actually occurs. Labelled by Bean *Solenites Murrayana.* The very slender needles reach a length of 15 cm., and are ·5 cm. in breadth. In one tuft the short basal portion is indistinctly preserved.

Other specimens:—**13,518** (leaves 17 cm. long).

Class CONIFERÆ.

Order ARAUCARIINÆ.

Genus **ARAUCARITES**, Presl.

[Flor. Vorwelt, vii. p. 203, 1838.]

Araucarites Phillipsi, Carruthers.

[Geol. Mag. vol. vi. (1), p. 6, pl. ii. figs. 7-9, 1869.]

(Pl. X. Fig. 4.)

1869. *Araucarites Phillipsii*, Carruthers, Geol. Mag. vol. vi. [1], p. 6, pl. ii. figs. 7-9.
1870. *Araucaria Phillipsii*, Schimper, Trait. pal. vég. vol. ii. p. 254.
1872. *Araucarites Phillipsii*, Balfour, Palæont. Botany, pl. ii. fig. 11.
1875. *Araucarites Phillipsii*, Phillips, Geol. Yorks. p. 229, pl. x. fig. 5.
1888. *Araucarites Phillipsii*, Schenk, Foss. Pflanz. p. 171.
1890. *Araucaria Phillipsii*, Schenk, in Zittel, p. 280.
1892. *Araucaria Phillipsii*, Fox-Strangways, Tab. Foss. p. 136.

Type-specimen. In the Leckenby Collection, Cambridge (No. 305).

The species *Araucarites Phillipsii* was founded by Carruthers on some single scales, and on an imperfect rolled specimen of a female cone. He gives the following description:—

"Scales from the centre of the cone cuneate, nearly as broad as long, lower scales thickish throughout, without membranous wings."

The detached scales of this species are frequently met with in collections of Inferior Oolite plants, but no good specimen has been found showing the cone as a whole. Occasionally single seeds are found detached from the scales; these are elliptical in form, and slightly more than 1 cm. in length. Although the material on which Carruthers founded his species is somewhat meagre, there can be no reasonable doubt that it affords trustworthy evidence of the existence of cones of the Araucarian type. The occurrence of

Araucarian cones in the Wealden rocks of Sussex[1] and such specimens as *Araucarites Hudlestoni*, Carr.,[2] from the Coralline Oolite of Yorkshire, affords proof of the comparative abundance of Araucarian species in Mesozoic floras; but as yet we are not in a position to do more than suggest what form of vegetative shoots were borne by these species of *Araucarites*. It is, however, very probable that the twigs of Wealden and Inferior Oolite age referred to Fontaine's genus *Nageiopsis* and Bunbury's species *Cryptomerites divaricatus* were borne by plants closely allied to *Araucaria*.

The English Jurassic species may be compared with the Indian specimens described by Feistmantel as *Araucarites cutchensis*[3] and *A. kachensis*.[4] Similar, but somewhat larger, cone-scales have been described by Saporta under the name *Araucaria Moreauana*.

As Carruthers has pointed out, *Araucarites Phillipsi* agrees most closely with the recent species of *Araucaria* included in the section *Columbea*.

39,317. Pl. X. Fig. 4.

A single scale showing the form of the central seed. Labelled by Bean "seed of *Cycadites*."

Scarborough. *Bean Coll.*

V. 2640. A large slab of sandstone with single scales of *Araucarites* and fragments of *Brachyphyllum mamillare*, Brongn.

? ARAUCARIINÆ.

Genus **CRYPTOMERITES**, Bunbury.

[Quart. Journ. Geol. Soc. vol. vii. p. 191, 1851.]

Bunbury instituted this generic name as a designation for some specimens of Coniferous shoots which he compared with *Cryptomeria japonica*, Don, and species of *Araucaria*; he uses the term "without meaning to affirm" that the species so named "is truly a congener of *Cryptomeria japonica*."

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[1] Seward (95), p. 190, pl. xii. figs. 1 and 2.
[2] Carruthers (77).
[3] Feistmantel (76), pl. ix. figs. 1–3.
[4] Ibid. (77³), pl. xiv.

Cryptomerites divaricatus, Bunbury.

[Quart. Journ. Geol. Soc. vol. vii. p. 190, pl. xiii. figs. 4*a*, 4*b*, 1851.]

1851. *Cryptomerites? divaricatus*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 190, pl. xiii. fig. 4.
1854. *Cryptomerites divaricatus*, Morris, Brit. Foss. p. 6.
1864. *Cryptomerites? divaricatus*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77.
1875. *Cryptomerites divaricatus*, Phillips, Geol. Yorks. p. 230, lign. 62.
C. rigidus, ibid. p. 231, lign. 63.
1876. *Pachyphyllum* (*Cryptomerites*) *divaricatum*, Feistmantel, Pal. Ind. pl. x. fig. 1.
1877. *Cryptomerites divaricatus*, Lebour, Illustrations Foss. Plants, pl. lvii.
1890. *Cryptomerites divaricatus*, Schenk, in Zittel, p. 280.
C. rigidus, ibid. p. 280.
1892. *Cryptomerites divaricatus*, Fox-Strangways, Tab. Foss. p. 137.
C. rigidus, ibid. p. 137.

Type-specimen. The original of Bunbury's figure is in the Leckenby Collection, Cambridge (No. 303).

In his description of the two specimens from the collection of Dr. Murray on which the species was founded, Bunbury gives the following diagnosis of the vegetative characters of the plant:—

"The main axis is stout, straight, and rigid; the branches and branchlets spread widely and stiffly, having a rigid and wiry aspect, although the branchlets are very slender and somewhat zigzag. Leaves apparently two-ranked, mostly alternate, but placed at very irregular intervals and often nearly opposite; they are compressed sideways, and taper regularly from the vertically dilated decurrent base to a sharp point; are of rigid appearance, most commonly straight, sometimes decidedly incurved; have no prominent lateral rib or angle, but are rather faintly and irregularly striated, perhaps in consequence of the shrinking of their tissue. Those towards the base of each twig are often rather stouter than the rest."

Bunbury compares the specimens with *Cryptomeria japonica*, but he also recognizes a resemblance to *Araucaria excelsa*, R. Br., and *A. Cunninghamii*, Ait.

Nathorst[1] has drawn attention to the resemblance between *Cryptomerites divaricatus* and the sterile branches of some forms of

[1] Nathorst (80[1]), p. 72.

Araucaria (section *Eutacta*). In the absence of reproductive structures it is difficult to form an opinion as to the affinities of this plant, but the striking similarity which the leaves and the form of the branches of the fossil type bear to the recent Australian species *Araucaria Cunninghamii*, Ait., leads me to favour the view of the Araucarian relationship of Bunbury's species.

I have little doubt as to the specific identity of the specimens named by Phillips *Cryptomerites rigidus* with *C. divaricatus*, Bunb. This Conifer is represented by a very small number of specimens in collections of Inferior Oolite plants; the best specimens I have seen are Bunbury's type-specimen (Leckenby Collection) and a few good examples in the Manchester Museum.

Genus **NAGEIOPSIS**, Fontaine.

[Potomac Flora, p. 194, 1889.]

This generic name was chosen by Professor Fontaine for certain vegetative shoots bearing a resemblance in the form of the leaves to recent species of the genus *Podocarpus*, included in the section *Nageia*, in which the leaves possess numerous veins and not a single midrib.[1] As no reproductive organs have been found in connection with the vegetative shoots of *Nageiopsis*, the position of the genus cannot be definitely fixed. While admitting the marked similarity between Fontaine's genus and certain species of *Podocarpus*, a comparison may also be made, as Nathorst has suggested, with the Australian Conifer *Araucaria Bidwillii*, Hook.

Nageiopsis anglica, sp. nov.

(Text-fig. 51.)

Type-specimen. Whitby Museum (2503). (Text-fig. 51.)

Leaves distichous, attached to the short axis by a narrow base, broadly linear in form, from 1 to 1·5 cm. in length, traversed by several parallel veins, which converge slightly towards the leaf-base.

This species is founded on some specimens in the Whitby Museum which are too fragmentary to admit of a satisfactory

[1] Seward (95), p. 210.

diagnosis. The close agreement between the English specimens and some of the larger fossils referred by Fontaine, in his *Monograph of the Potomac Flora*, to the genus *Nageiopsis*, leads me to adopt this name, although it is not improbable that the genus *Araucaria* may prove to be the nearest living representative. A specimen of similar form to that from the Inferior Oolite of Yorkshire has been described from the Wealden beds of Sussex,[1] but the two types are probably not specifically identical.

One of the Whitby specimens (2377) bears a label on which is written "Probably the leaves of *Araucaria Phillipsi.*" Nathorst, in his notes on English specimens, refers to what is probably the same plant; he speaks of fragments of branches in the Whitby



FIG. 51.—*Nageiopsis anglica*, sp. nov. (⅘ nat. size.) From a specimen in the Whitby Museum (No. 2503).

Museum resembling *Araucaria* (sect. *Columbea*), in appearance like *Zamites*, but in their branched form resembling *Araucaria Bidwilli*, Hook.[2]

Without more evidence we cannot decide definitely between the Podocarpeæ and Araucariinæ as the family in which to include the vegetative shoots referred to the genus *Nageiopsis*, but on the whole the comparison with *Araucaria* is more likely to be nearer the truth.

The English specimens, which I have described for the sake of convenience under a distinct specific name, may prove to be

[1] Seward (95), p. 211, pl. xii. fig. 3.
[2] Nathorst (80[1]), p. 73.

identical with one of the American forms figured by Fontaine; the Potomac species *Nageiopsis microphylla*, Font., *N. descrescens*, Font., and others[1] are very similar to the Whitby fragments.

Text-fig. 51. Whitby Museum, No. 2503.

This fragment shows clearly the form and disposition of the broadly linear leaves, 1·2–1·5 cm. in length; the axis of the specimen has a length of 3 cm.

Another specimen (2377) in the Whitby Collection consists of several pieces of branches similar to that shown in the figure; in one fragment the axis of the shoot is branched, as in the Wealden specimen already referred to. Each leaf is traversed by several parallel veins, which converge slightly towards the point of attachment of the narrow leaf-base.

? CONIFERÆ INCERTÆ SEDIS.

Genus PAGIOPHYLLUM, Heer.

[Secc. Trab. Geol. Portugal, p. 11, 1881.]

Saporta[2] and other authors incline to the view that the species included in Heer's genus should be regarded as members of the Araucarineæ, but this opinion is based very largely on a similarity of vegetative structures, which does not receive decisive support from such evidence as is afforded by the more important reproductive structures. While recognizing the possibility of a close relationship between this widespread Mesozoic genus and *Araucaria*, it is safer to regard *Pagiophyllum* as one of the numerous extinct forms which cannot be safely included in any particular family of the Coniferæ. It is difficult to draw a satisfactory line between the genera *Pagiophyllum* and *Elatides*, and perhaps the English Jurassic species, which I have placed in the former genus, should rather be referred to Heer's genus *Elatides*, the name under which Nathorst[3] has recently included the plant described by Lindley & Hutton as *Lycopodites Williamsonis*.

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[1] Fontaine (89), pls. lxxvii., lxxxvi., etc.

[2] Saporta (84), p. 373.

[3] Nathorst (97), p. 34.

Pagiophyllum Williamsoni (Brongniart).

[Prodrome, p. 83, 1828.]

(Pl. X. Figs. 2 and 3; Text-fig. 52.)

1828. *Lycopodites Williamsonis*, Brongniart, Prodrome, p. 83.
1829. *Lycopodites uncifolius*, Phillips, Geol. Yorks. p. 147, pl. viii. fig. 3.
1833. *Lycopodites Williamsonis*, Lindley & Hutton, Foss. Flor. vol. ii. pl. xciii.
1848. *Walchia Williamsonis*, Bronn, Ind. Pal. p. 1374.
1849. *Palissya? Williamsonis*, Brongniart, Tableau, p. 106.
1849. *Moreaunia Williamsonis*, Pomel, Amt. Bericht. Versam. Naturforsch. etc. p. 352.
1850. *Lycopodites Williamsonis*, Unger, Gen. spec. plant. foss. p. 273.
1851. *Palissya? Williamsonis*, Bunbury, Quart. Journ. Geol. Soc. vol. vii. p. 191.
1854. *Walchia Williamsonis*, Morris, Brit. Foss. p. 24.
1864. *Lycopodites Williamsonis*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
1870. *Pachyphyllum Williamsoni*, Schimper, Trait. pal. vég. vol. ii. p. 251.
1875. *Walchia Williamsonis*, Phillips, Geol. Yorks. p. 230, pl. viii. figs. 1 and 3, lign. 61.
1884. *Pachyphyllum? Williamsoni*, Saporta, Pal. Franç. vol. iii. p. 306, pl. clxii. figs. 1, 2.
1890. *Araucaria Williamsoni*, Schenk, in Zittel, p. 280.
1892. *Walchia Williamsonis*, Fox-Strangways, Tab. Foss. p. 141.
1894. Cf. *Pagiophyllum falcatum*, Bartholin, Bot. Tidsskrift, p. 100, pl. v. fig. 4.
1897. *Elatides Williamsonis*, Nathorst, Mesoz. Flora Spitzbergens, p. 84.
1900. *Pagiophyllum Williamsoni*, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 16.

Type-specimen. The specimens figured by Lindley & Hutton (pl. xciii. figs. 1 and 2) are in the Manchester Museum (Nos. 16 and 48). The original of Phillips' figure (pl. viii. fig. 1) is in the York Museum.

Vegetative shoots are monopodially branched, the latest branches being given off at an acute angle; the leaves, which are thick and fleshy, angular in form, and with a falcate, acuminate, and dorsally keeled distal portion, are crowded and spirally disposed.

The female cones, about 6 cm. in length, consist of a central axis, bearing imbricate scales with broadly acuminate tips; the male cones have a length of rather more than 2 cm.; the sporophylls are given off at right angles from a fairly stout axis; they have

a triangular apical portion, at right angles to the sporophyll axis, which is characterized by a median vertical keel.

As the list of synonyms shows, this fairly common species has been referred to various genera; that it is a Conifer there is no longer any doubt, both male and female cones having been found in organic connection with the vegetative branches. It is, however, a little difficult to decide in which family of the Coniferæ *Pagiophyllum Williamsoni* should be included. The form of the leaves and the general appearance of the branches at once suggest a comparison with certain species of *Araucaria*, e.g. *Araucaria excelsa*, R. Br., the Norfolk Island pine, but such knowledge as we possess as to the structure of the cones does not enable us to decide the question of Araucarian affinity. The male flowers are not sufficiently well preserved to afford any decisive evidence as to the number of the pollen-sacs or their manner of attachment to the stamens; their external form agrees closely with that of the male flowers of various types of the Abietineæ, and in itself does not supply confirmatory evidence of a close relationship with *Araucaria*.

The present species bears a close resemblance to *Pagiophyllum peregrinum* (L. & H.), of Liassic age, described from the English Lias and elsewhere. Some of the coniferous twigs described under Heer's generic name *Elatides* are very similar to *Pagiophyllum Williamsoni*; as Heer points out, the Siberian Jurassic species *Elatides falcata*[1] resembles the English type, but the leaves of the latter are much broader at the base. The distinction between the two genera *Pagiophyllum* and *Elatides* is by no means well marked, and either generic term might be used as a suitable designation for certain Mesozoic coniferous twigs.

Several specimens of this species are included in the collections of Whitby, Scarborough, Cambridge, and elsewhere; both the male and female cones are not infrequently found in organic connection with the vegetative shoots.

13,516. Pl. X. Fig. 3.

This specimen illustrates the characteristic falcate leaves and the form of the female cones borne on slender lateral branches.

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[1] Heer (77), vol. iv (2), p. 79, pl. xiv. fig. 6.

The cones are imperfectly preserved, and do not throw much light on the structural features.

Gristhorpe Bay. *Presented by Dr. Murray.*

40,548. Pl. X. Fig. 2. A single male cone, 2·2 cm. long and 6 mm. broad. The individual sporophylls are fairly clearly shown (Fig. 2*b*); on the distal end of each is a keel-like ridge.

Scarborough. *Bowerbank Coll.*

39,312. Text-fig. 52. This specimen shows more clearly than that represented in Pl. X. Fig. 3 the form of the scales of the female cone. There are parts of three cones preserved, the most



Fig. 52.—*Pagiophyllum Williamsoni* (Brongn.). No. 39,312. (Nat. size.)

perfect only is shown in the drawing; it is 4 cm. broad and 2 cm. in diameter; the cone-scales as seen in side-view resemble the foliage-leaves, but they are rather less falcate.

Cloughton.

39,313. A single cone, 6 cm. × 2·3 cm.; many of the scales are imperfect, and present a truncated appearance; others show the pointed triangular apex. Labelled by Bean *Lycopodites uncifolius.*

Upper Sandstone, Cloughton. *Bean Coll.*

39,332. Several male cones, approximately 7 mm. broad and 2–2·5 cm. long; some are seen in longitudinal section, showing

a fairly short axis giving off the sporophylls at right angles. In some of the cones the triangular distal ends of the sporophylls are clearly seen.

Oolitic Shale, Scarborough.

40,519. A large specimen showing clearly the habit of branching, which agrees with that of *Pagiophyllum peregrinum* as figured by Saporta.

Other specimens:—**V. 3575, 11,015, 13,524, 39,319, 39,325, 39,327** (labelled by Bean *Lycopodites uncifolius*).

Genus CHEIROLEPIS, Schimper.

[Trait. pal. vég. vol. ii. p. 247, 1870.]

This generic term was instituted by Schimper as a substitute for Brongniart's *Brachyphyllum* in the case of certain forms which do not conform to the vegetative characters of the typical species, *B. mamillare*. The species referred to *Cheirolepis* agree, as regards the form of the leaves, with *Widdringtonia* and *Sequoia gigantea*; the cone-scales are described as bearing solitary seeds. The plant which Schenk[1] named *Brachyphyllum Muensteri* is the type species of Schimper's genus.

Cheirolepis setosus (Phillips).

[Phillips, Geol. Yorks. p. 229, lign. 60, 1875.]

(Text-figs. 53A and B).

1875. *Brachyphyllum setosum*, Phillips, Geol. Yorks. p. 229, lign. 60.
1890. *Brachyphyllum setosum*, Schenk, in Zittel, p. 287.
1892. *Brachyphyllum setosum*, Fox-Strangways, Tab. Foss. p. 137.

This species was instituted by Phillips in the third edition of his *Geology of Yorkshire*, and defined as follows:—

"Stem branching at obtuse angles, marked by alternate elongate cicatrices; leaves arranged round an axis, lanceolate, pointed, small, short, crowded."

[1] Schenk (67), p. 187, pl. xliii.

The description is accompanied by a sketch made by Professor Williamson from a specimen in his collection.

The two examples shown in Text-figs. 53 A and B are, no doubt, identical with the type of Phillips; the more acute angle at which the small branches are given off can hardly be regarded as a difference of specific importance. This type of Conifer is represented by a single specimen in the British Museum; those shown in Figs. 53 A and B are from the Scarborough and Whitby Museums respectively. With such fragmentary material it is impossible to construct any satisfactory diagnosis, and in the absence of cones we cannot adduce evidence of a trustworthy character as to the probable relationship of this rare form to recent genera. Such few specimens as have been obtained seem to warrant the separation of this species from *Pagiophyllum Williamsoni*; the falcate and stiff leaves bear a fairly close resemblance, on a small scale, to the large leaves of the latter species, but the much smaller size of the vegetative twigs of *Cheirolepis setosus* and the somewhat different habit afford distinctive characters.

The question of generic designation is not an easy one to decide in dealing with fragmentary branches of fossil Conifers. The twigs of this species have not been found with any trace of cones, and the only characters available are afforded by the habit and the form and arrangement of the leaves. Certain authors have used the genus *Brachyphyllum* in a wide sense, so as to include branches with sharply pointed, small, and somewhat falcate keeled leaves, as well as branches with closely adpressed broad scale-leaves, such as occur in *Brachyphyllum mamillare*, Brongn. It is better, however, to restrict this generic designation to fossil Conifers in which the leaves are broad and inserted on the stem by a rhomboidal base, and to include branches with the narrow and more spreading leaves under different generic names. There is the closest resemblance between the specimens represented in Fig. 53 and *Brachyphyllum Muensteri*, as figured by Schenk from beds of Rhætic age;[1] while hesitating to refer the Yorkshire fossils to this species, the agreement of the vegetative characters suggests specific identity. Saporta[2] substitutes the

[1] Schenk (67), pl. xliii.
[2] Saporta (84), p. 490.

genus *Cheirolepis* for *Brachyphyllum* in describing Schenk's species, and wisely restricts the application of the latter term. The Wealden Conifer, *Sphenolepidium Kurrianum* (Dunk.),[1] also bears a distinct resemblance to the Jurassic species; but in both *Sphenolepidium* and *Cheirolepis* the nature of the cones is included as an important generic character in the diagnosis. In the case of Phillips' *Brachyphyllum setosum* we are without the important evidence which cones would supply, and it must be admitted that

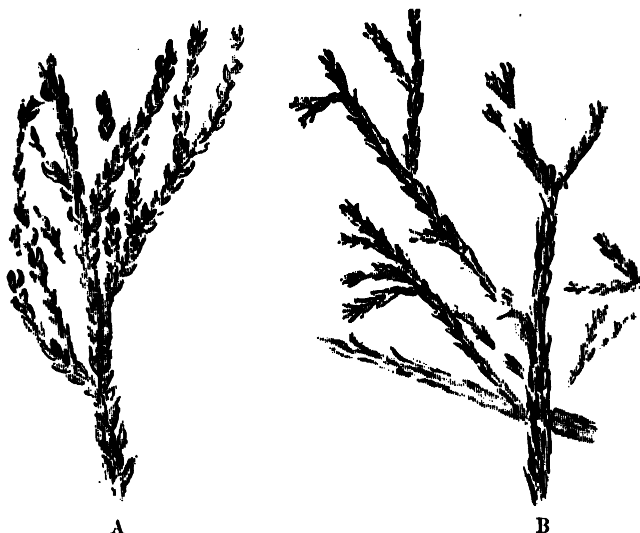


FIG. 53.—*Cheirolepis setosus* (Phill.).
A. From the Scarborough Museum. (Nat. size.)
B. From the Whitby Museum (No. 2382). (Nat. size.)

the form of the vegetative branches alone is insufficient as a guide to affinity when we have to deal with such a type as that represented in Fig. 53.

While admitting the impossibility of determining with certainty the true generic nature of the specimens of this species, we may adopt *Cheirolepis* as a generic designation in preference to

[1] Seward (95), p. 200, pls. xvii. and xviii.

Brachyphyllum, and as indicating the very close resemblance between the Yorkshire plant and *Cheirolepis Muensteri*, Schenk.

The vegetative shoots branch at a more acute angle than in *Brachyphyllum*. The leaves are crowded, spirally disposed, fairly stout, and falcate in form.

The fragments of this species resemble in habit *Sequoia gigantea*, Lindl. & Gord., and may be compared also with *Araucaria Balansæ*, Brongn. & Gris., and *Dacrydium Franklinii*, Hook., but the material is too meagre and ill preserved to admit of a full diagnosis or of a satisfactory comparison with recent Conifers.

40,570. Several fragments similar to the Scarborough example (Fig. 53A); imperfect and fragmentary.

Genus BRACHYPHYLLUM, Brongniart.

[Tableau, p. 69, 1849.]

The genus *Brachyphyllum*,[1] like many other fossil Conifers, cannot be safely assigned to any definite position among recent genera. The habit of the branches and the form of the leaves favour a comparison with some species of the Tasmanian genus *Arthrotaxis*; but we are not in a position to speak with confidence as to affinities of this common Mesozoic genus.

Brachyphyllum mamillare, Brongniart.

[Prodrome, p. 109, 1828.]

(Pl. X. Fig. 1.)

1828. *Brachyphyllum mamillare*, Brongniart, Prodrome, p. 109.
1829. *Thuites expansus*, Phillips, Geol. Yorks. pp. 147 and 153, pl. x. fig. 11.
1835. *Thuites expansus*, Lindley & Hutton, Foss. Flor. vol. iii. pl. clxvii.
1836. *Brachyphyllum mamillare*, ibid. pl. clxxxviii.
1837. *Brachyphyllum mamillare*, ibid. pl. ccxix.
1848. *Brachyphyllum mamillare*, Bronn, Ind. Pal. p. 173.
1849. *Brachyphyllum mamillare*, Brongniart, Tableau, p. 106.
? *B. majus*, ibid. p. 106.
1850. *Brachyphyllum mamillare*, Göppert, Mon. Conif. p. 241.
B. mamillare, Unger, Gen. spec. plant. foss. p. 388.

[1] Seward (95), p. 214.

1854. *Brachyphyllum mamillare*, Morris, Brit. Foss. p. 3.
1864. *Brachyphyllum mamillare*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 76.
Thuites expansus, ibid.
1870. *Brachyphyllum mamillare*, Schimper, Trait. pal. vég. vol. ii. p. 335.
B. Phillipsi, ibid. p. 336.
1875. *Brachyphyllum mamillare*, Phillips, Geol. Yorks. p. 229.
Thuites expansus, ibid. p. 229, pl. x. fig. 11, lign. 59.
1876. ? *Echinostrobus* (*Thuites*) *expansus*, Feistmantel, Pal. Ind. pl. ix. figs. 6–9.
1877. ? *Brachyphyllum mamillare*, ibid. pl. x. fig. 12; pl. xi. figs. 12 and 13.
1884. *Brachyphyllum mamillare*, Saporta, Pal. Franç. vol. iii. p. 326, pl. clxii. figs. 3–7.
1890. *Brachyphyllum mamillare*, Schenk, in Zittel, p. 301.
1892. *Brachyphyllum mamillare*, Fox-Strangways, Tab. Foss. p. 137.
Thuites expansus, ibid. p. 141.
1900. *Brachyphyllum mamillare*, Seward, Manchester Lit. and Phil. Soc. vol. xliv. p. 17.

Type-specimen. The original of pl. clxvii. of Lindley & Hutton is in the Manchester Museum (No. 52).

In habit the branches of *Brachyphyllum mamillare* resemble those of *Arthrotaxis cupressoides*, Don; the branches of different order are given off at a fairly wide angle. The leaves are small, fleshy, triangular in shape, with a median dorsal keel, crowded and spirally disposed. There is no satisfactory evidence as to the nature of the flowers.

There has been some confusion on the part of palæobotanical authors between *Brachyphyllum mamillare*, Brongn., and *Thuites expansus*, Sternb.; the specimens to which Phillips and Lindley & Hutton applied the latter name are undoubtedly identical with those designated by Brongniart *Brachyphyllum mamillare*.

The specimen from the Gristhorpe plant-bed, which is figured by Lindley & Hutton as *Thuites expansus*, is, I have no doubt, specifically identical with the plant which these authors represent in plates clxxxviii. and ccxix. as *Brachyphyllum mamillare*. The specimen has a length of 9·5 cm., and represents an imperfectly preserved twig, bearing short lateral branches clothed with spirally disposed and fleshy broadly triangular scale-leaves, closely adpressed to the axis. Each leaf terminates in a sharp point, and is traversed on the abaxial surface by a fairly prominent median ridge.[1]

[1] Seward (00), p. 18.

Nathorst mentions a specimen which he found in a plant-bed on the Yorkshire coast as probably new to England and identical with the Indian *Brachyphyllum mamillare* of Feistmantel, which Nathorst thinks is not specifically identical with Brongniart's species.[1] Among the Yorkshire examples of *Brachyphyllum* I have not discovered any specimens which appear to be specifically distinct from *B. mamillare*.

39,315. Pl. X. Fig. 1.

This specimen serves to illustrate the characteristic habit of the species. The branch has a length of 12 cm., and gives off lateral members at an angle of approximately 80°.

Yorkshire. *Bean Coll.*

V. 2511. A fairly well preserved branch, labelled by Bean *Brachyphyllum mamillare*.

Scarborough. *Purchased.*

V. 2640. A large slab with numerous fragments of branches; also several seeds of *Araucarites Phillipsi*, Carr., and portions of stems of *Equisetites columnaris* (Brongn.).

Yorkshire. *Beckles Coll.*

V. 3296. Some of the leaves in this specimen show the dorsal rib and the triangular form of the apex; they are not very closely adpressed to the branches, but stand out from the axis and clearly exhibit their pointed triangular form. *Purchased.*

V. 3583. A fairly good specimen, 14 cm. long; the thick fleshy leaves are well shown.

10,380. In this specimen the leaves are more open in their arrangement and less closely adpressed to the stem than in the more typical examples of the species.

Other specimens:—**V. 2525, V. 2570, V. 2893, V. 3476, V. 3582, 10,335, 10,338, 40,467.**

[1] Nathorst (80[1]), p. 28.

Genus TAXITES, Brongniart.

[Prodrome, p. 108, 1828.]

In speaking of this generic name Brongniart points out its artificial character, and calls attention to the fact that several other recent Conifers agree very closely with the Yew in the form of the vegetative shoots.[1] In the absence of any evidence as to the character of the flowers, we may conveniently retain Brongniart's genus for the fragments described by Leckenby from the Inferior Oolite of East Yorkshire.

Taxites zamioides (Leckenby, ex Bean MS.).

[Quart. Journ. Geol. Soc. vol. xx. p. 77, pl. viii. fig. 1; 1864.]

(Pl. X. Fig. 5.)

1864. *Cycadites zamioides*, Leckenby, Quart. Journ. Geol. Soc. vol. xx. p. 77, pl. viii. fig. 1.
1870. *Cycadites zamioides*, Schimper, Trait. pal. vég. vol. ii. p. 178.
1875. *Cycadites zamioides*, Phillips, Geol. Yorks. p. 228, lign. 58.
Taxites laxus, ibid. p. 231, pl. vii. fig. 24, lign. 64.
1879. ? *Taxites planus*, Feistmantel, Pal. Ind. vol. i. p. 31, pls. xiii.–xv.
1885. *Cycadites zamioides*, Zigno, Flor. foss. Oolit. vol. ii. p. 139.
1889. Cf. *Cephalotaxopsis ramosa*, Fontaine, Potomac Flora, pls. cvi.–cviii.
1890. *Cycadites zamioides*, Schenk, in Zittel, pp. 217, 287, 326.
Taxites laxus, ibid. p. 270.
1892. *Cycadites zamioides*, Fox-Strangways, Tab. Foss. p. 138.
Taxites laxus, ibid. p. 141.

Type-specimen. The specimen figured by Leckenby is in the Woodwardian Museum, Cambridge (No. 286). The vegetative shoots resemble those of *Taxus baccata*, *Sequoia sempervirens*, and other recent species; they consist of a slender axis bearing narrow linear leaves, traversed by a single median vein. The leaves are spirally disposed and more or less closely set. Flowers unknown.

The fragment to which Phillips gave the name *Taxites laxus* is in all probability specifically identical with *Cycadites zamioides*, Leck. The spiral disposition of the leaves, as well as the small

[1] Brongniart (28[2]), p. 75.

size and habit of the shoots, clearly demonstrate that Leckenby's plant is a Conifer and not a Cycad. On the type-specimen of *Cycadites zamioides* (Geological Museum, Cambridge) Nathorst has written "a Conifer of the genus *Palissya*." Another specimen in the Leckenby Collection is labelled in Bean's handwriting *Zamia angustifolia*.

The few fragments of this species that are known are too small to enable us to make any suggestions as to relationship with recent types. It is probable that *Taxites zamioides* is specifically identical with some of the Coniferous branches described by Fontaine from the Potomac beds under the generic name *Cephalotaxopsis*; a term applied to twigs with distichous leaves having the habit of species of such recent genera as *Cephalotaxus*, *Torreya*, and *Taxus*.[1]

39,288. Pl. X. Fig. 5.

A slender axis bearing crowded, spirally disposed leaves, which have assumed a distichous arrangement. The individual leaves show a fairly clear midrib; they are sharply pointed distally, and decrease rapidly in breadth at the base; from 2–3 cm. in length.

Scarborough. *Bean Coll.*

39,202. A fragment with fewer and more scattered leaves. Cf. Phillips' fig. 24, pl. vii.

Scarborough. *Bean Coll.*

[1] Fontaine (89), p. 235.

CONCLUSION.

In the present volume we have practically confined our attention to the fossil plants from the Inferior Oolite (Bathonian) strata of the Yorkshire coast. A comparison of the Yorkshire flora with those of the Stonesfield Slate and other Jurassic horizons will be more appropriately undertaken after the completion of the systematic treatment of the species in a succeeding volume. The flora with which we are now concerned is the richest among Mesozoic floras from British localities both as regards the number of species and the abundance of material, and is scarcely surpassed by any assemblage of fossil plants from extra-British regions.

A general survey of a geological flora should include the consideration of such points as the following: (i.) The geographical distribution of the several types composing the flora; (ii.) a comparison with older and younger floras, and with recent species; (iii.) the conditions under which the plants grew; and (iv.) the recognition of the most characteristic species which may serve as the best indices of geological age.

In attempting to determine the geographical range of the several elements of the Yorkshire Coast flora, we have to face serious difficulties. It is often impossible to decide whether an English species is identical with or merely closely allied to a species recorded from another region. If we ignore all records but those which can be interpreted with satisfactory accuracy, without any doubt as to the specific position of the plants, our comparisons would be restricted within limits which would not enable us to do full justice to the available data. In the comparison of floras more or less widely separated geographically, the recognition of specific identity is naturally desirable, but the object of a comparative study of fossil floras is primarily to determine resemblances and differences as regards the general facies of the vegetation rather than the absolute specific identity of individual plants. In the following table I have indicated the geographical range of the English species, without giving any indication as to the degree of

confidence with which each determination has been made. Many of the extra-British types are undoubtedly specifically identical with Yorkshire species, but in other cases the foreign species may possibly be identical with those from the Yorkshire coast, or they may represent specifically distinct but closely allied types.

It should be borne in mind, therefore, that the accompanying table is not intended to convey the idea that all the references to the occurrence of Yorkshire plants in foreign localities necessarily imply specific identity; each record denotes the occurrence of either the same species or a closely allied or representative species. In the lists of plants given in the Introductory section and in the comparisons instituted in the systematic treatment of each species, I have attempted to show how far I regard English species identical with or closely allied to extra-British types.

In addition to the geographical regions given in the table, it is worthy of note that some Rhætic species from South American localities[1] are very similar to English types; from Madagascar also Zeiller[2] has recently recorded the occurrence of a few species—e.g. *Klukia* (*Pecopteris*) *exilis*—identical with or nearly related to Inferior Oolite types.

I propose to consider more fully the stratigraphical correlation of Mesozoic floras in a subsequent volume, but there are some points of geological and botanical interest which should be noticed in reference to the flora with which we are at present concerned. The comparison of the English plants with the Upper Gondwana flora of India and with Australian floras of corresponding geological position, has confirmed me in my opinion that the differences between the Mesozoic vegetation of the Northern and Southern Hemispheres have been exaggerated. Geographical separation of fossil species frequently leads to an unnecessary amount of specific distinction in the naming and determination of plants. We naturally hesitate to admit specific identity between plants from such widely separated regions as England on the one hand, and India, South Africa, and Australia on the other; but the too frequent use of distinct generic and specific designations has obscured the botanical resemblances of the Northern and Southern floras. The number

[1] Vide ante, p. 38

[2] Zeiller (00[2]).

List of Species.	England (East Yorkshire).	France and Belgium.	Germany and Austria.	Portugal.	Switzerland.	Russia and Poland.	Sweden, Bornholm, and Denmark.	Italy.	Arctic Regions (Greenland, Siberia, Spitzbergen Franz Josef Land, etc.).	North America (United States and Canada).	Japan.	China.	Australia.	India.	Persia.
Marchantites erectus ...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Equisetites columnaris ...	x	x	x	x	...	x	...	x	x	...	...	...	x	...	...
Equisetites Beani	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Lycopodites falcatus ...	x	...	...	...	...	...	...	...	...	...	...	...	...	x	...
Cladophlebis denticulata ...	x	...	x	...	...	x	x	...	x	x	x	x	x	x	x
Cladophlebis haiburnensis...	x	...	...	...	...	x	...	...	...	...	...	...	...	...	...
Cladophlebis lobifolia ...	x	...	...	...	...	x	x	...	...	...	...	...	...	x	...
Coniopteris arguta ...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Coniopteris hymenophylloides	x	x	...	x	...	x	x	x	x	x	x	x	x	x	...
Coniopteris quinqueloba ...	x	x	...	x	...	...	...	...	...	...	...	...	...	...	...
Dictyophyllum rugosum ...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...
Klukia exilis	x	...	...	...	...	x	...	...	x	...	x	...	...	...	...
Laccopteris polypodioides ...	x	...	x	...	...	...	x	x	...	...	...	...	x	...	...
Laccopteris Woodwardi ...	x	x	...	...	...	x	x	...	...	...	...	...	...	...	...
Matonidium Goepperti ...	x	x	x	x	...	x	...	...	...	x	...	...	...	...	...
Pachypteris lanceolata ...	x	x	x	...	...	...	...	x	...	...	...	...	...	x	...
Ruffordia Goepperti ...	x	x	x	x	...	x	...	...	...	...	x	...	...	...	...
Sagenopteris Phillipsi ...	x	...	...	...	x	x	x	x	...	x	...	...	...	...	...
Sphenopteris Murrayana ...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Sphenopteris princeps ...	x	...	x	...	...	x	...	...	...	...	...	...	...	...	...
Sphenopteris Williamsoni	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Tæniopteris major ...	x	...	...	...	...	...	...	...	...	...	...	...	...	x	...
Tæniopteris vittata ...	x	...	...	...	...	x	x	...	x	...	x	x	x	x	...

Todites Williamsoni ...	x	...	x	...	...	x	...	x	x	x	x	x	...	...	x
Anomozamites Nilssoni ...	x	...	...	...	...	...	...	...	x	...	...	x	...	...	...
Araucarites Phillipsi ...	x	x	...	...	...	...	...	...	...	...	...	...	...	...	...
Baïera gracilis	x	x	...	...	...	...	...	..	x	x	...	x	x	...	...
Baiera Lindleyana ...	x	x	...	...	...	...	x	...	x	x	...	...	...	...	...
Baiera Phillipsi	x	...	...	...	...	...	...	...	x	x	...	...	...	...	...
Beania gracilis	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Brachyphyllum mamillare	x	x	...	...	...	...	...	...	...	...	...	...	...	x	...
Cheirolepis setosus ...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cryptomerites divaricatus	x	...	...	...	...	...	...	...	...	...	...	...	...	x	...
Ctenis falcata	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Ctenis, sp.	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Czekanowskia Murrayana	x	...	...	...	...	...	...	...	x	x	...	...	...	...	...
Dioonites Nathorsti ...	x	...	...	...	...	...	...	...	...	...	...	...	...	x	...
Ginkgo digitata	x	...	x	...	...	x	x	...	x	x	x	...	...	...	...
Ginkgo whitbiensis ...	x	...	..	...	...	...	...	...	...	x	...	...	...	...	...
Nageiopsis anglica ...	x	...	...	...	...	...	...	...	...	...	x	...	...	...	...
Nilssonia compta	x	...	...	...	...	...	...	...	x	...	...	x	...	x	...
Nilssonia mediana ...	x	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Nilssonia tenuinervis ...	x	...	...	...	...	...	x	...	x	...	...	...	...	...	...
Otozamites acuminatus ...	x	x	...	...	...	...	...	...	...	...	...	...	...	...	...
Otozamites Beani	x	x	...	...	...	...	...	x	...	...	...	...	...	...	...
Otozamites Bunburyanus ...	x	...	...	...	...	...	...	x	...	...	...	...	...	...	...
Otozamites Feistmanteli ...	x	...	x	...	...	...	...	x	...	...	...	...	x	x	...
Otozamites graphicus ...	x	x	...	...	...	...	...	x	...	...	...	...	...	...	...
Otozamites obtusus, var. *ooliticus*	x	x	...	...	...	...	...	...	...	...	...	...	...	...	...
Otozamites parallelus ...	x	...	...	...	...	...	...	x	...	...	...	...	...	...	...
Pagiophyllum Williamsoni	x	x	...	...	...	...	x	...	x	x	...	x	...	...	...
Podozamites lanceolatus ...	x	...	x	...	...	x	x	...	x	x	x	x	x	x	x
Ptilozamites Leckenbyi ...	x	...	...	...	...	...	...	...	...	x	...	...	...	...	x
Taxites zamioides	x	...	...	...	...	...	...	...	...	x	...	...	...	x	...
Williamsonia gigas ...	x	x	x	...	x	...	...	...	...	x	...	...	...	x	...
Williamsonia pecten ...	x	x	x	x	...	...	...	x	...	...	...	x	...	x	...

of Indian and Australian fossils recorded in the above table, some being no doubt identical and others specifically distinct but closely allied species, illustrates a marked similarity between the vegetation of the ancient Gondwana Land and the European continent. In Jurassic times there was no doubt a much greater uniformity in the vegetation of the world than exists at the present day. A closer analysis of the Gondwana floras and a more detailed comparison with those of the Northern Hemisphere may enable us to recognize well-defined distinguishing features suggestive of botanical provinces such as existed in the Lower Gondwana period,—but this is a matter for subsequent treatment.

The resemblance between the Wealden flora, described in two previous British Museum Catalogues,[1] and the Jurassic flora of East Yorkshire, has been already noticed. In a few instances we find what appear to be identical species common to the two periods, e.g., *Matonidium Goepperti*, *Ruffordia Goepperti*, and *Ginkgo digitata*. In addition to the occurrence of the same species, we recognize several plant-types in the two floras which demonstrate the marked similarity between the Wealden and Inferior Oolite floras. Comparing the two floras, we notice as common characteristics the absence of Angiosperms and an abundance of Cycads and Ferns: the Conifers probably played a somewhat more prominent rôle in the Wealden than in the older Jurassic vegetation.

The following figures illustrate the similarity in the composition

	Wealden.	Inferior Oolite.
Bryophyta	1	1
Equisetales ...	3	2
Filices	21	20
Cycadales	19	23
Coniferæ.........	15	9

of the English Wealden and Jurassic vegetation as regards the relative prominence of the different classes of plants; the figures are convenient as a means of comparison, but they must not be

[1] Seward (94[1]) (95).

regarded as giving more than an approximate estimate of the composition of each flora. It is probable that the vegetation which has left fairly abundant traces in the Wealden sediments of the South-East of England and in the Inferior Oolite beds of Yorkshire, flourished under very similar climatal and physical conditions.

A comparison of the Inferior Oolite plants with those of Rhætic age from Germany, Scania, and other regions leads us to recognize a few examples of what appear to be identical species, e.g., *Podozamites lanceolatus* and *Sphenopteris princeps*. Several instances of closely related types have also been pointed out in the introductory and systematic sections of this volume.

We may next briefly consider some of the more conspicuous members of the Inferior Oolite flora from the point of view of their resemblance to other fossil types as well as to recent plants.

EQUISETALES.—*Equisetites columnaris* is one of the commonest and most characteristic plants in the Yorkshire flora. Its abundance lends support to the view that the small seams of coal met with in the strata of the Estuarine Series were probably in great measure, if not entirely, formed from the remains of the Equisetaceous plants which grew in the Jurassic swamps. The thicker stems described under the name *Equisetites Beani* are comparable in size to *E. arenaceus* of Triassic age, and surpass in diameter the characteristic Rhætic form *E. Muensteri*. Compared with such Wealden species as *Equisetites Lyelli* and *E. Burchardti* the Inferior Oolite Equisetaceæ are distinguished by the greater thickness of their stems, and in this respect they carry us a stage further from the modern Horsetails towards the arborescent representatives of the Equisetales, which flourished during the Triassic and Palæozoic epochs.

FILICES.—Among the Inferior Oolite ferns there are several species which cannot be referred to any particular subdivision of the filices, but on the other hand we have sufficient evidence in many cases to admit of a satisfactory identification of family affinities. The species *Sagenopteris Phillipsi*, which for reasons already stated I have included among the filices rather than the Rhizocarpeæ, may not improbably belong to the Polypodiaceæ, but of this we have not sufficient evidence. The species is of interest as a common type, which forms a connecting link on the one hand with the older and larger Rhætic forms *Sagenopteris*

rhoifolia and *S. Goeppertiana* and on the other with the smaller Wealden type *S. Mantelli.*

In the case of the abundant and handsome fern *Cladophlebis denticulata* we lack convincing evidence of family relationship, but such indications of soral characters as occur point to a polypodiaceous affinity. The bipinnate form of frond of this species is practically identical with that of certain Rhætic ferns, e.g. *Cladophlebis Roesserti*, and with ferns of Wealden age, e.g. *C. Albertsi*. Ferns of the *Cladophlebis denticulata* type are very abundant in Mesozoic strata, but in most cases we are unable to determine their systematic position; this form of frond is in itself of little or no use as an aid to the recognition of botanical relationship.

As Nathorst has stated, it is not improbable that some of the Sphenopteroid fronds from the Inferior Oolite rocks may be best compared with species of the recent Polypodiaceous genus *Davallia*.

Passing from these rather doubtful examples of Jurassic Polypodiaceæ, we may turn to other more satisfactory fern species. It is clear that the Matonineæ played a prominent part in the vegetation of the Oolitic period; *Matonidium Goepperti* and the two species of *Laccopteris*, *L. polypodioides* and *L. Woodwardi*, are fairly abundantly represented by well-preserved fertile specimens. This interesting family, with two surviving species in the Malayan region, occupied an even more prominent position in the Rhætic than in the Jurassic period. From Rhætic times, when the family appears to have reached its maximum development, the Matonineæ gradually decrease in importance, and at the present day the genus *Matonia* alone remains as a survival from Mesozoic times.

Dipteridinæ.—This family, treated as a subdivision distinct from the Polypodiaceæ for reasons already discussed,[1] appears to have a geological history similar to that of the Matonineæ. *Dictyophyllum rugosum*, one of the more abundant of Inferior Oolite types, is practically indistinguishable from *D. Nilssoni*, *D. acutilobum*, and other Rhætic species. The genera *Camptopteris* and *Clathropteris* afford other Rhætic examples of the same family, and in the Wealden flora we have the genus *Protorhipis*, which approaches most closely to the surviving fern *Dipteris*, another tropical remnant of a Mesozoic family.

[1] Ante, p. 119.

Osmundaceæ.— *Todites Williamsoni* must have been one of the most conspicuous and abundant ferns which flourished during the Jurassic period. It is possible that *Sphenopteris princeps* should also be included in this family, but we lack such convincing evidence of affinity as is afforded by the fertile specimens of *Todites Williamsoni*. The Rhætic species described by Schenk as *Acrostichites Goeppertianus* appears to be barely distinguishable from the Inferior Oolite species of *Todites*: from the Wealden plant-beds no satisfactory representative of the Osmundaceæ has so far been recorded.

The *Cyatheaceæ* are represented by such species as *Coniopteris hymenophylloides*, one of the most characteristic of the Yorkshire Coast ferns, *C. quinqueloba*, and *C. arguta*. There is a striking resemblance between some of these fossil Cyatheaceæ and the isolated recent fern *Thyrsopteris elegans*. The Inferior Oolite flora was characterized by an abundance of ferns of the *Thyrsopteris* type.

Among Wealden ferns we have the genus *Protopteris*, which may probably be included as a member of the Cyatheaceæ, a type which extends into still more recent geological periods.

Schizæaceæ.—In addition to the somewhat doubtful *Ruffordia Goepperti* of Wealden and Inferior Oolite age, we have an excellent example of this family in the widely distributed *Klukia exilis*, a species which may also be closely matched among Wealden ferns. Neither the Cyatheaceæ nor the Schizæaceæ are represented by any well-authenticated Rhætic species, but in the Palæozoic genus *Senftenbergia* we have a still older type which exhibits well-marked Schizæaceous characters. *Klukia exilis* agrees precisely as regards the structure of the sporangia with the living members of the family, but in the form of the frond it differs from the modern representatives of the Schizæaceæ.

The Yorkshire Coast Flora has not so far yielded any recognizable examples of the Gleicheniaceæ or the Marattiaceæ; species of the former family are known to have existed during the Wealden period, and we have a representative of the latter family in the Rhætic fern *Tæniopteris Muensteri*. From the Jurassic plant-beds of Poland, Raciborski has described a member of the Marattiaceæ under the name *Danæa*. Neither the Hymenophyllaceæ nor the Ophioglossaceæ appear to have any representatives among the Inferior Oolite plants. The statement that certain families of ferns are not represented, simply means that we have not discovered any

fossils among the Yorkshire plants which afford sufficiently good evidence to warrant their inclusion in these families; it is possible that *Tæniopteris vittata*, which is one of the commonest species, may belong to the Marattiaceæ, and it may be that some of the Sphenopteroid fronds possessed Hymenophyllaceous soral characters.

It is among the ferns of the Southern Hemisphere that we find the closest resemblances to the Inferior Oolite species. The Malayan species *Matonia pectinata* is essentially a Jurassic and Lower Cretaceous type; the Indian and Malayan *Dipteris* recalls *Dictyophyllum rugosum*. *Thyrsopteris elegans* of Juan Fernandez, *Dicksonia arborescens* of St. Helena, *Balantium culcita* of Madeira and the Azores may be cited as Cyatheaceous types most nearly allied to those of Jurassic age. *Todea barbara*, a native of New Zealand and tropical Australia, is the nearest living representative of *Todites Williamsoni*. The Schizæaceæ are to-day widely distributed in both hemispheres, but several members of the family are characteristic of Southern latitudes.

GINKGOALES.—The two genera *Ginkgo* and *Baiera*, although both appear to have been in existence in the Triassic and even Permian periods, are essentially characteristic of Rhætic and Jurassic floras. The Inferior Oolite species of *Baiera* are very similar to Rhætic forms, while *Ginkgo digitata* is for the most part a Jurassic and Cretaceous type of wide geographical range. The trees, which bore the *Ginkgo* and *Baiera* foliage, and flowers, which were probably rather more Cycadean in structure than those of the recent Maidenhair-tree, must have formed a striking feature in the Jurassic vegetation. The extreme northern range of *Baiera* and *Ginkgo* points to a vigorous development of the Ginkgoales during the latter part of the Mesozoic era.

CYCADALES.—At no period in the earth's history were the Cycadaceæ more abundantly represented than in Jurassic times. *Williamsonia*, *Nilssonia*, and *Otozamites* are the most conspicuous examples of the Cycadales in the Yorkshire flora; *Williamsonia gigas* may be compared with the English Wealden type *W. Carruthersi*; *Williamsonia pecten* is one of the most abundant and at the same time one of the most characteristic of the Inferior Oolite species. The Bennettiteæ appear to have attained their maximum development in the Upper Jurassic and Lower Cretaceous periods; the two species *Williamsonia gigas* and *W. pecten* are typical Jurassic types, and *Anomozamites Nilssoni* recalls the Rhætic

species *A. minor*. The species of *Otozamites*, which played a very prominent part in the composition of the Inferior Oolite flora, afford points of contact with both Rhætic and Wealden types, but this genus is primarily characteristic of Jurassic floras. I have already pointed out that some of the Jurassic Cycadean fronds exhibit a closer approach to the fronds of ferns than is the case with modern Cycads, with the exception of *Stangeria paradoxa*.[1]

Nilssonia compta is one of the commonest species in the Yorkshire Coast flora, but its close resemblance to *N. polymorpha* and other Rhætic types detracts from its value as an index of geological age. In the Wealden flora the genus *Nilssonia* is represented by a smaller-leaved form, *N. Schaumburgensis*. No example of the genus *Cycadites* has so far been recognized among the East Yorkshire plants.

Ctenis falcata is a characteristic species in the Inferior Oolite flora; the larger form, described as *Ctenis* sp., recalls some of the species described by Raciborski from Poland as well as certain Rhætic examples from Scania and elsewhere.

Podozamites lanceolatus is a Mesozoic type of wide geographical range occurring chiefly in Rhætic and Jurassic strata, and less abundant in more recent beds; it is not improbable that this species may be best compared with the conifer *Agathis australis* rather than with Cycads.

CONIFERÆ.—The Conifers are much less abundant than either the Ferns or Cycads; it is impossible to determine how far this may be taken as an indication that they played but an insignificant part in the vegetation, or as resulting from the less favourable position of the Conifers—which probably occupied higher ground farther from the area of sedimentation—as regards the chances of fossilization. In all probability the Coniferæ were less numerous and represented by fewer types than either the Cycads or Ferns. So far as we are able to form an opinion as to the systematic position of the Inferior Oolite Conifers, it would seem that their affinities are chiefly with the Araucarinæ. *Nageiopsis anglica* represents a type which is much more abundant in North American beds of Wealden or Upper Jurassic age than in European regions; it may be compared with *Araucaria Bidwilli* or with certain species of *Podocarpus*. *Araucarites Phillipsi* is

[1] Ante, pp. 170, 203, 208, 212, etc.

certainly an Araucarian type; *Pagiophyllum Williamsoni* recalls *Araucaria excelsa*, and *Cryptomerites divaricatus* bears a close resemblance to *Araucaria Cunninghamii*. The vegetative characters of *Brachyphyllum mamillare* invite a comparison with the Tasmanian genus *Arthrotaxis*.

Admitting the danger of drawing conclusions from such imperfect data as the Conifers afford, we are probably justified in asserting that *Araucaria*, *Arthrotaxis*, and possibly *Podocarpus* and *Agathis*, among existing genera agree the most nearly with Inferior Oolite types. The Abietineæ have no certain represcentives in the East Yorkshire flora; this family assumed a much more important position in the succeeding Wealden and Lower Cretaceous vegetation.

In conclusion, we may endeavour to answer the question, what assemblage of recent plants would we select as best illustrating the character of the Inferior Oolite vegetation? The large Equisetums of the marshes of South America most nearly recall the fossil forms, while a species of *Selaginella*, a genus of wide distribution, and represented by several tropical examples in the Southern Hemisphere, may be taken as affording the nearest approach to *Lycopodites falcatus*. Among Ferns we have *Matonia pectinata*, *Dipteris conjugata*, *Todea barbara*, species of *Lygodium* and *Anemia*, *Balantium* (*Dicksonia*), and *Thyrsopteris*. Among recent Cycads, the fronds of certain species of *Zamia*, *Encephalartos*, *Bowenia*, and others recall the habit of some of the Jurassic types. *Ginkgo biloba* alone survives as a representative of the Ginkgoales, and is probably but slightly different from its Jurassic ancestors. Of existing Conifers we may select *Araucaria*, *Arthrotaxis*, and *Podocarpus* as types exhibiting the nearest approach to the Inferior Oolite species. It is in the Southern tropics that we must look for existing forms which afford the most striking links between the vegetation of to-day and that which has left imperfect records in the Jurassic sediments of the Yorkshire coast. The climate was presumably more tropical than that of North Europe at the present day; there is no evidence that the plants of Jurassic times grew under conditions which induced xerophytic characters, moisture being probably abundant and favourable to the luxuriant growth of Equisetums and Ferns.

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[Synonyms are printed in *italics*. Asterisks denote illustrations in the text.]

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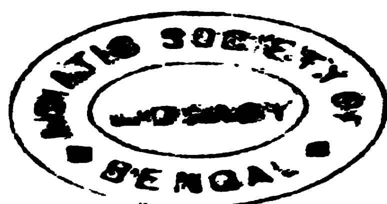
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EXPLANATION OF PLATES.

With a few exceptions the figured specimens are preserved in the British Museum (Natural History), their registered numbers being quoted in square brackets. Except where otherwise stated, the figures are drawn natural size.

PLATE I.

FIG. 1. *Otozamites obtusus* (Lindley & Hutton), var. *ooliticus*, mihi. Page 220. [39,201.]

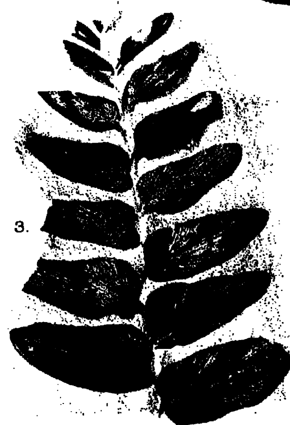
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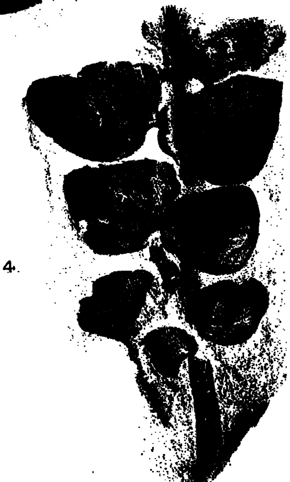
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FIG. 4. *Otozamites Beani* (L. & H.). P. 209. [40,568.]









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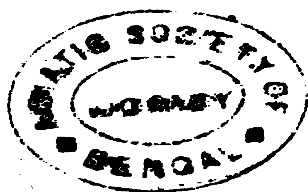


PLATE II.

FIG. 1. *Otozamites acuminatus* (Lindley & Hutton), var. *brevifolius*. Page 216. [40,468.]

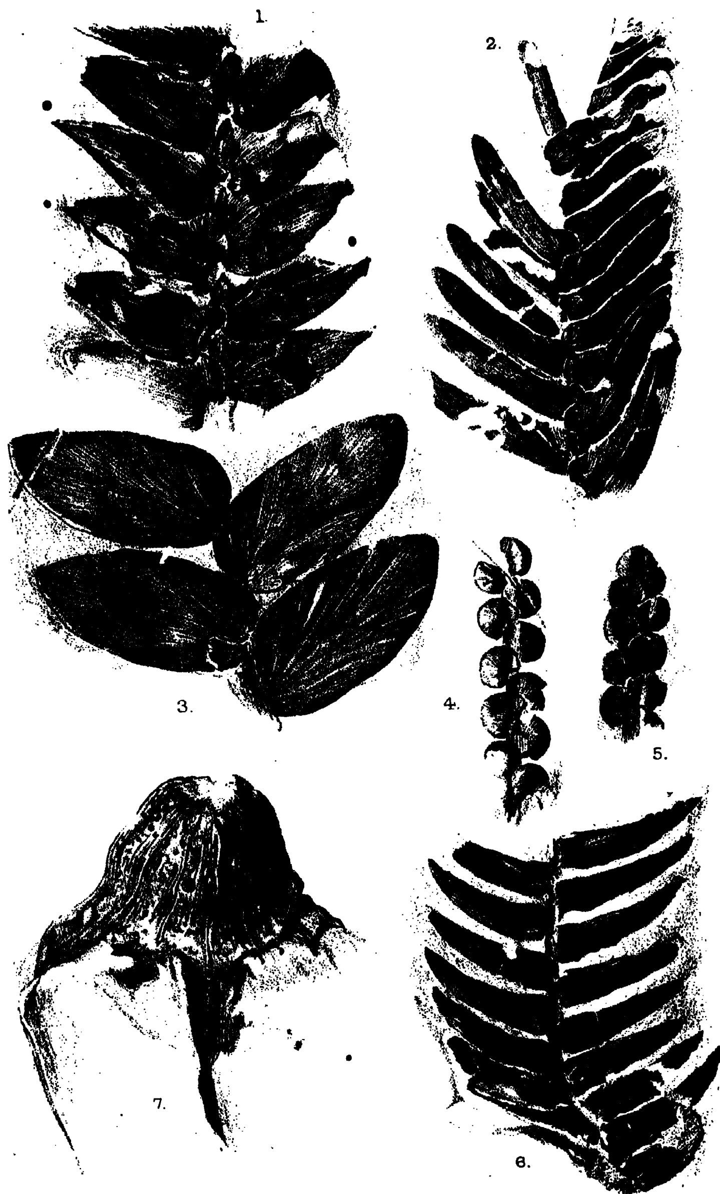
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FIG. 7. *Williamsonia pecten* (Phillips). Slightly enlarged. P. 201. [V. 3688.]



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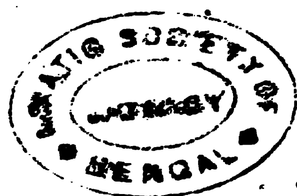


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Fig. 1. *Williamsonia pecten* (Phillips). Page 197. [48,732.]

Fig. 2. *Williamsonia pecten* (Phill.). P. 197. [V. 3517.]

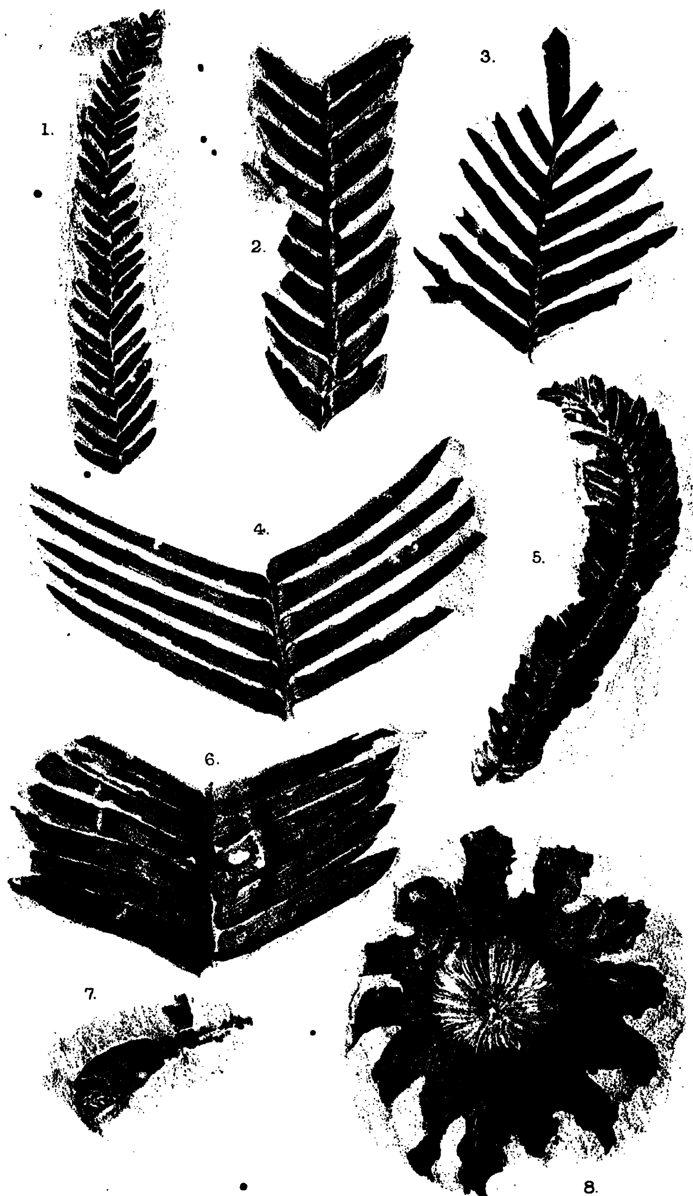
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Fig. 7. *Williamsonia pecten* (Phill.). P. 200. [13,515.]

Fig. 8. *Williamsonia pecten* (Phill.). P. 201. [V. 3284.]



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PLATE IV.

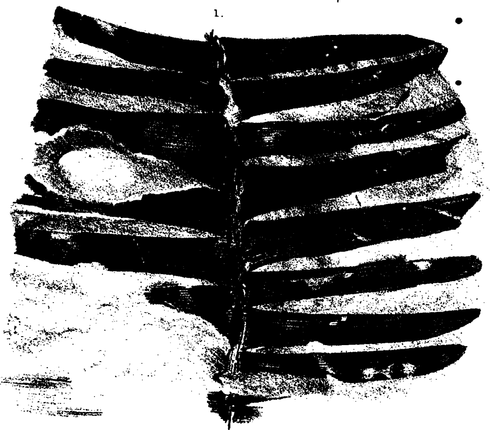
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FIG. 2. *Nilssonia mediana* (Leckenby, ex Bean MS.). P. 229. [39,290.]

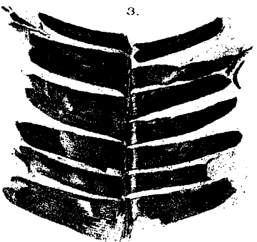
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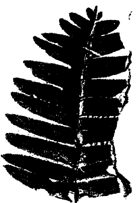
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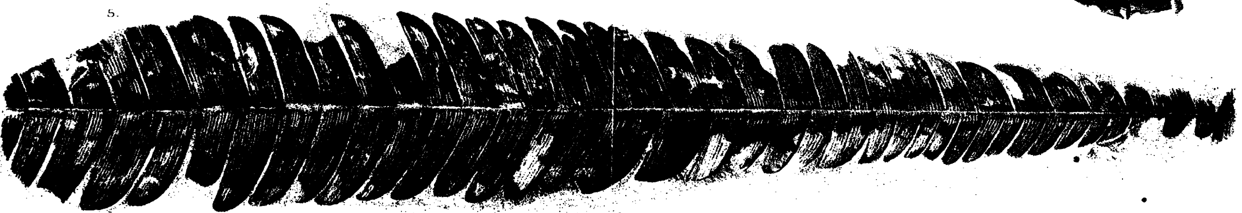
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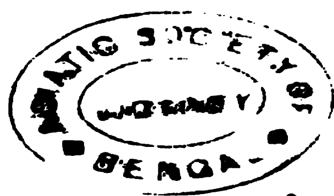


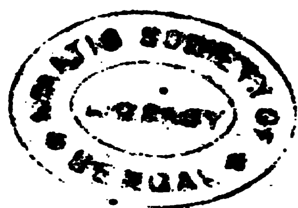
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E. RAY LANKESTER,
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